

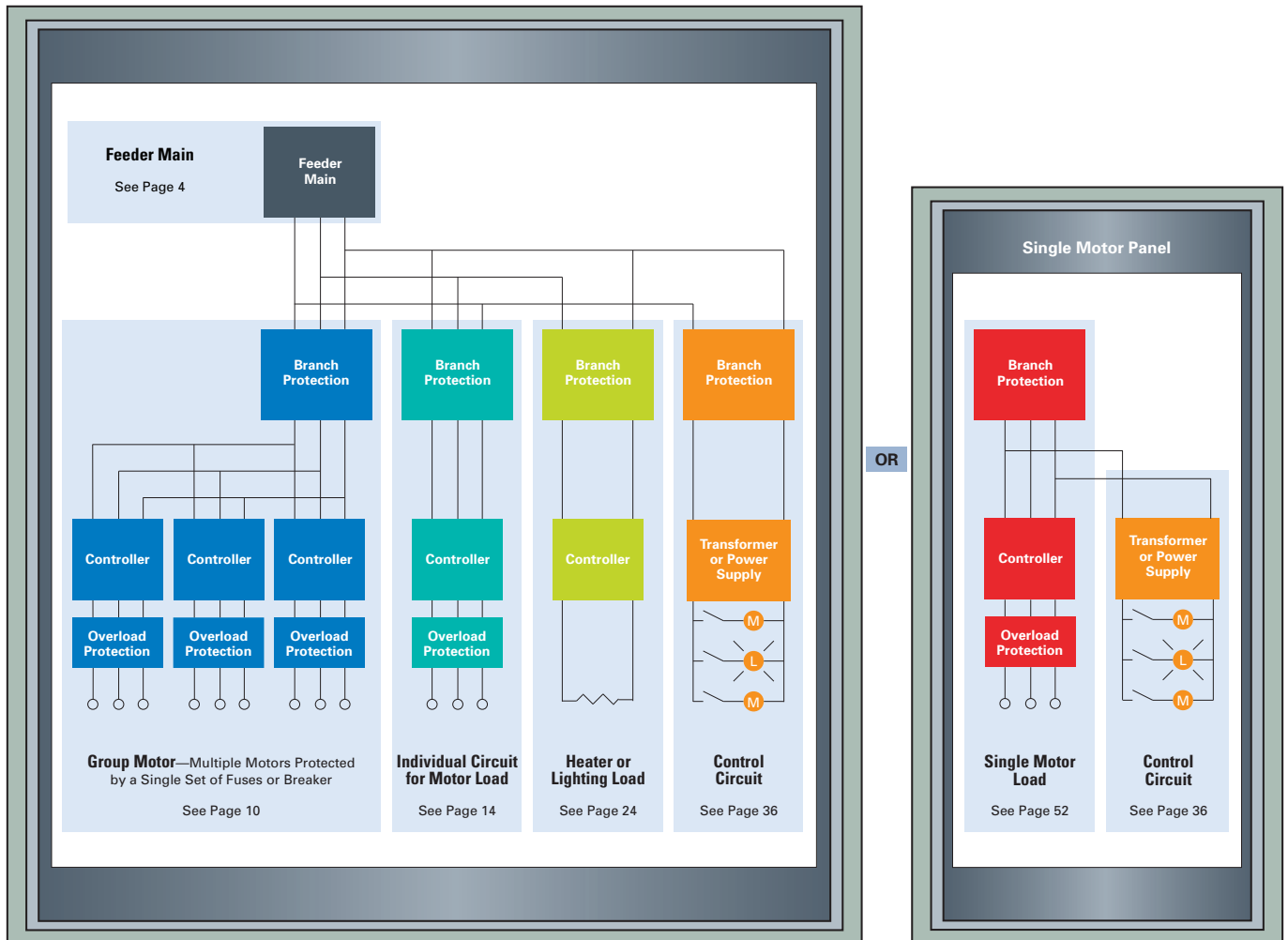
# Control panel design guide according UL 508A

Build it in.



*Powering Business Worldwide*

# Designing the panel

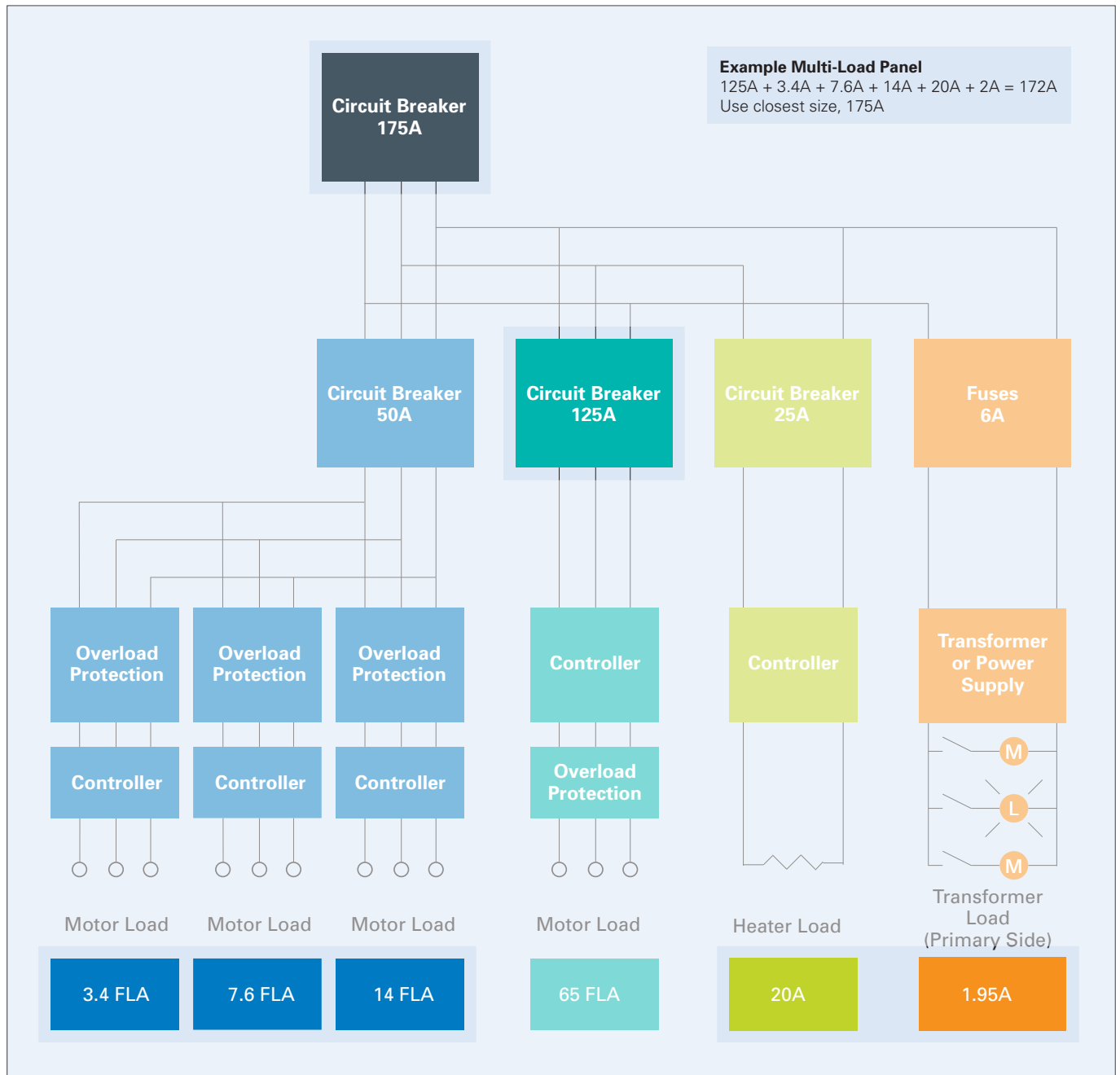


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# Sizing the feeder

Reference to UL 508A Section 32.3.1a

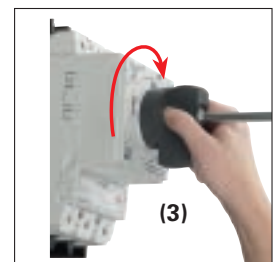
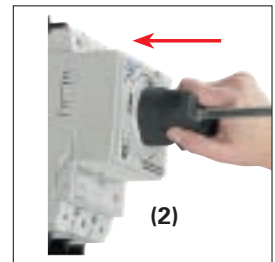
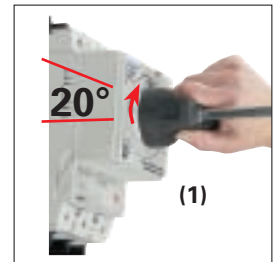


The feeder amp rating is sized based on the sum of the amp rating of the largest branch protective device plus the full-load currents of the other loads.

In this example, the 125A circuit breaker is the largest short-circuit protective device. This value is added to the full load

currents of the other loads in the circuit (motors, heater, and the primary of the transformer).

The overcurrent feeder amp rating should not exceed the conductor ampacity rating on the loadside. For conductor ampacity ratings, see UL508 A Table 28.1.






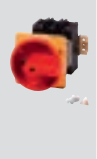

## Fulfilling key requirements of relevant North American standards






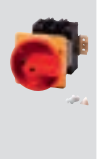

Main disconnect switches (Circuit Breakers and Molded Case Switches) equipped with door mounted rotary handles, and installed in industrial control panels for industrial machinery applications, essentially require the use of an additional internally mounted supplementary handle in order to meet all of the requirements found in the relevant North American standards dealing with this application. Eaton's assortment of new supplementary handles meet these stricter requirements in both the UL 508A and NFPA 79 standards.

Whitepaper download:  
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# UL 489 Circuit Breaker and Molded Case Switch Selection

rated current	circuit breaker			fuse acc. NEC/CEC	Molded Case Switch		main switch assembly kit with additional rotary handle					
	Part no.	SCCR 480Y/ 277V kA	SCCR 480V		SCCR 600Y/ 347V	SCCR 480Y/ 277V kA	SCCR 480V	SCCR 600Y/ 347V	black	red-yellow		
A												
15	NZMB2-AF15(-BT)-NA	25	25	18	15	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF15(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF15(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
					15		P3-30...-MCS	10				
20	NZMB1-AF20-NA	25			20	NS1-63-NA		35			NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMN1-AF20-NA	35									NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMB2-AF20(-BT)-NA	25	25	18	20	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF20(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF20(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
					20		P3-30...-MCS	10				
25	NZMB1-AF25-NA	25			25	NS1-63-NA		35			NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMN1-AF25-NA	35									NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMB2-AF25(-BT)-NA	25	25	18	25	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF25(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF25(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
					25		P3-30...-MCS	10				
30	NZMB1-AF30-NA	25			30	NS1-63-NA		35			NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMN1-AF30-NA	35									NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMB2-AF30(-BT)-NA	25	25	18	30	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF30(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF30(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
					30		P3-30...-MCS	10				
35	NZMB1-AF35-NA	25			35	NS1-63-NA		35			NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMN1-AF35-NA	35									NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMB2-AF35(-BT)-NA	25	25	18	35	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF35(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF35(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
40	NZMB1-AF40-NA	25			40	NS1-63-NA		35			NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMN1-AF40-NA	35									NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMB2-AF40(-BT)-NA	25	25	18	40	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF40(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF40(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
45	NZMB1-AF45-NA	25			45	NS1-63-NA		35			NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMN1-AF45-NA	35									NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMB2-AF45(-BT)-NA	25	25	18	45	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF45(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF45(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
50	NZMB1-AF50-NA	25			50	NS1-63-NA		35			NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMN1-AF50-NA	35									NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMB2-AF50(-BT)-NA	25	25	18	50	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF50(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF50(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA

# UL 489 Circuit Breaker and Molded Case Switch Selection

rated current	circuit breaker			fuse acc. NEC/CEC	Molded Case Switch			main switch assembly kit with additional rotary handle				
	Part no.	SCCR 480Y/ 277V kA	SCCR 480V		SCCR 600Y/ 347V	SCCR 480Y/ 277V kA	SCCR 480V	SCCR 600Y/ 347V	black	red-yellow		
A												
60	NZMB1-AF60-NA	25			50	NS1-63-NA		35		NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA	
	NZMN1-AF60-NA	35								NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA	
	NZMB2-AF60(-BT)-NA	25	25	18	60	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF60(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF60(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
70	NZMB1-AF70-NA	25			70	NS1-100-NA		35			NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMN1-AF70-NA	35									NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMB2-AF70(-BT)-NA	25	25	18	70	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF70(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF70(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
80	NZMB1-AF80-NA	25			80	NS1-100-NA		35			NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMN1-AF80-NA	35									NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMB2-AF80(-BT)-NA	25	25	18	80	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF80(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF80(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
90	NZMB1-AF90-NA	25			90	NS1-100-NA		35			NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMN1-AF90-NA	35									NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMB2-AF90(-BT)-NA	25	25	18	90	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF90(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF90(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
100	NZMB1-AF100-NA	25			100	NS1-100-NA		35			NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMN1-AF100-NA	35									NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMB2-AF100(-BT)-NA	25	25	18	100	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF100(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF100(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
110	NZMB1-AF110-NA	25			110	NS1-125-NA		35			NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMN1-AF110-NA	35									NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMB2-AF110(-BT)-NA	25	25	18	110	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF110(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF110(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
125	NZMB1-AF125-NA	25			125	NS1-125-NA		35			NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMN1-AF125-NA	35									NZM1-XHB-DA-NA	NZM1-XHB-DAR-NA
	NZMB2-AF125(-BT)-NA	25	25	18	125	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF125(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF125(-BT)-NA	150	150	65							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
150	NZMB2-AF150(-BT)-NA	25	25	18	150	NS2-160(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF150(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF150(-BT)-NA	100	100	50							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
175	NZMB2-AF175(-BT)-NA	25	25	18	175	NS2-200(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF175(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF175(-BT)-NA	100	100	50							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
200	NZMB2-AF200(-BT)-NA	25	25	18	200	NS2-200(-BT)-NA		100	100	50	NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMN2-AF200(-BT)-NA	35	35	35							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA
	NZMH2-AF200(-BT)-NA	100	100	50							NZM2-XHB-DA-NA	NZM2-XHB-DAR-NA

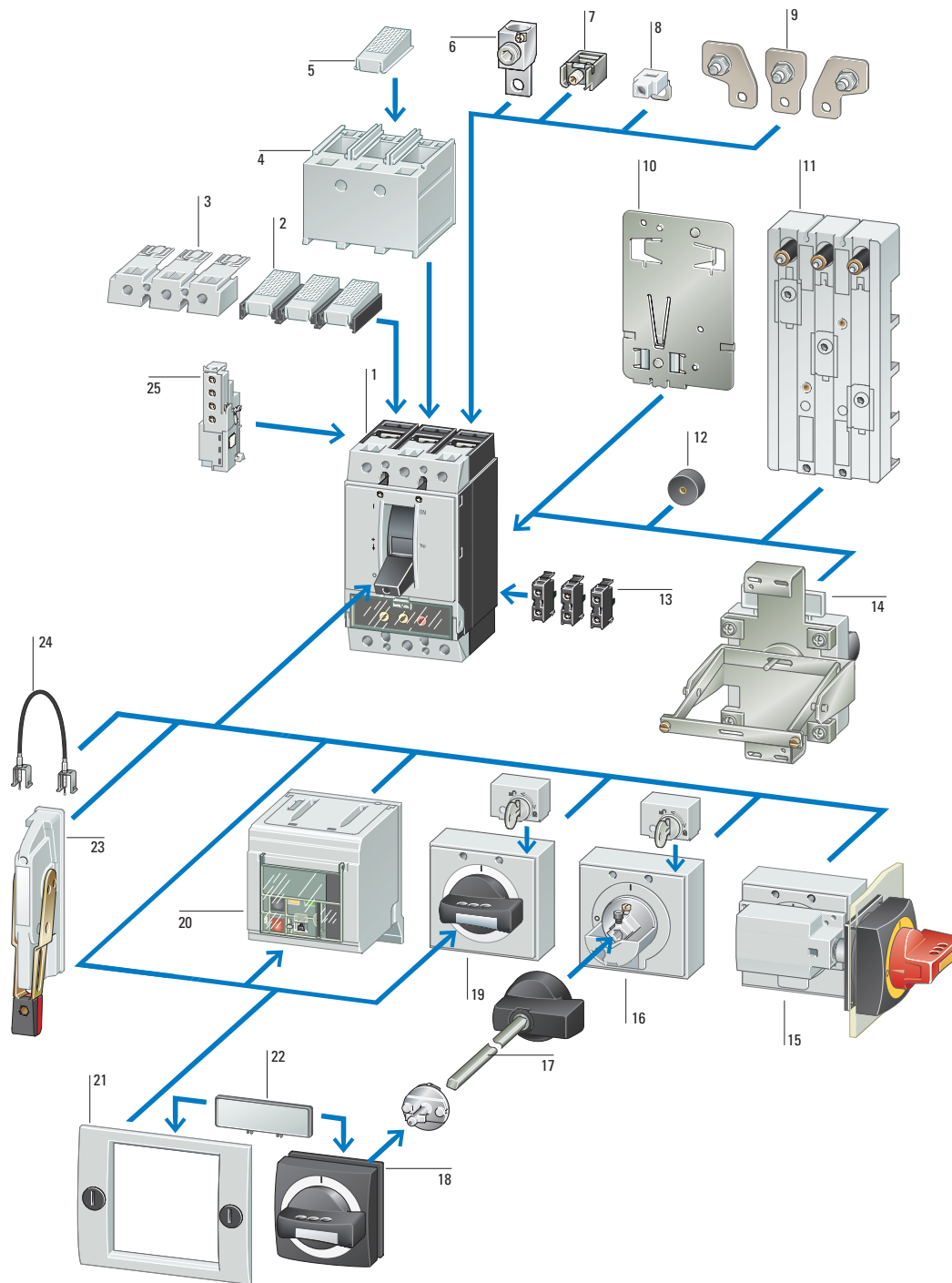
# UL 489 Circuit Breaker and Molded Case Switch Selection

rated current	circuit breaker			fuse acc. NEC/CEC	Molded Case Switch	SCCR			main switch assembly kit with additional rotary handle				
	Part no.	SCCR 480Y/ 277V kA	SCCR 480V			SCCR 600Y/ 347V	SCCR 480Y/ 277V kA	SCCR 480V	SCCR 600Y/ 347V	black	red-yellow		
A													
225	<b>NZMB2-AF225(-BT)-NA</b>	25	25	18	225	<b>NS2-250(-BT)-NA</b>			100	100	50	<b>NZM2-XHB-DA-NA</b>	<b>NZM2-XHB-DAR-NA</b>
	<b>NZMN2-AF225(-BT)-NA</b>	35	35	35								<b>NZM2-XHB-DA-NA</b>	<b>NZM2-XHB-DAR-NA</b>
	<b>NZMH2-AF225(-BT)-NA</b>	100	100	50								<b>NZM2-XHB-DA-NA</b>	<b>NZM2-XHB-DAR-NA</b>
250	<b>NZMB2-AF250(-BT)-NA</b>	25	25	18	250	<b>NS2-250(-BT)-NA</b>			100	100	50	<b>NZM2-XHB-DA-NA</b>	<b>NZM2-XHB-DAR-NA</b>
	<b>NZMN2-AF250(-BT)-NA</b>	35	35	35								<b>NZM2-XHB-DA-NA</b>	<b>NZM2-XHB-DAR-NA</b>
	<b>NZMH2-AF250(-BT)-NA</b>	100	100	50								<b>NZM2-XHB-DA-NA</b>	<b>NZM2-XHB-DAR-NA</b>
300	<b>NZMN3-AEF300-NA</b>	42	42	35	300	<b>NS3-400-NA</b>			100	100	50	<b>NZM3-XHB-DA-NA</b>	<b>NZM3-XHB-DAR-NA</b>
	<b>NZMH3-AEF300-NA</b>	100	100	50								<b>NZM3-XHB-DA-NA</b>	<b>NZM3-XHB-DAR-NA</b>
350	<b>NZMN3-AEF350-NA</b>	42	42	35	350	<b>NS3-400-NA</b>			100	100	50	<b>NZM3-XHB-DA-NA</b>	<b>NZM3-XHB-DAR-NA</b>
	<b>NZMH3-AEF350-NA</b>	100	100	50								<b>NZM3-XHB-DA-NA</b>	<b>NZM3-XHB-DAR-NA</b>
400	<b>NZMN3-AEF400-NA</b>	42	42	35	400	<b>NS3-400-NA</b>			100	100	50	<b>NZM3-XHB-DA-NA</b>	<b>NZM3-XHB-DAR-NA</b>
	<b>NZMH3-AEF400-NA</b>	100	100	50								<b>NZM3-XHB-DA-NA</b>	<b>NZM3-XHB-DAR-NA</b>
450	<b>NZMN3-AEF450-NA</b>	42	42	35	450	<b>NS3-600-NA</b>			100	100	50	<b>NZM3-XHB-DA-NA</b>	<b>NZM3-XHB-DAR-NA</b>
	<b>NZMH3-AEF450-NA</b>	100	100	50								<b>NZM3-XHB-DA-NA</b>	<b>NZM3-XHB-DAR-NA</b>
500	<b>NZMN3-AEF500-NA</b>	42	42	35	500	<b>NS3-600-NA</b>			100	100	50	<b>NZM3-XHB-DA-NA</b>	<b>NZM3-XHB-DAR-NA</b>
	<b>NZMH3-AEF500-NA</b>	100	100	50								<b>NZM3-XHB-DA-NA</b>	<b>NZM3-XHB-DAR-NA</b>
600	<b>NZMN3-AEF600-NA</b>	42	42	35	600	<b>NS3-600-NA</b>			100	100	50	<b>NZM3-XHB-DA-NA</b>	<b>NZM3-XHB-DAR-NA</b>
	<b>NZMH3-AEF600-NA</b>	100	100	50								<b>NZM3-XHB-DA-NA</b>	<b>NZM3-XHB-DAR-NA</b>
700	<b>NZMN4-AEF700-NA</b>	42	42	35	700	<b>NS4-800-NA</b>			65	65	42	<b>NZM4-XHB-DA-NA</b>	<b>NZM4-XHB-DAR-NA</b>
	<b>NZMH4-AEF700-NA</b>	85	85	50								<b>NZM4-XHB-DA-NA</b>	<b>NZM4-XHB-DAR-NA</b>
800	<b>NZMN4-AEF800-NA</b>	42	42	35	800	<b>NS4-800-NA</b>			65	65	42	<b>NZM4-XHB-DA-NA</b>	<b>NZM4-XHB-DAR-NA</b>
	<b>NZMH4-AEF800-NA</b>	85	85	50								<b>NZM4-XHB-DA-NA</b>	<b>NZM4-XHB-DAR-NA</b>
900	<b>NZMN4-AEF900-NA</b>	42	42	35	900	<b>NS4-1000-NA</b>			65	65	42	<b>NZM4-XHB-DA-NA</b>	<b>NZM4-XHB-DAR-NA</b>
	<b>NZMH4-AEF900-NA</b>	85	85	50								<b>NZM4-XHB-DA-NA</b>	<b>NZM4-XHB-DAR-NA</b>
1000	<b>NZMN4-AEF1000-NA</b>	42	42	35	1000	<b>NS4-1000-NA</b>			65	65	42	<b>NZM4-XHB-DA-NA</b>	<b>NZM4-XHB-DAR-NA</b>
	<b>NZMH4-AEF1000-NA</b>	85	85	50								<b>NZM4-XHB-DA-NA</b>	<b>NZM4-XHB-DAR-NA</b>
1200	<b>NZMN4-AEF1200-NA</b>	42	42	35	1200	<b>NS4-1200-NA</b>			65	65	42	<b>NZM4-XHB-DA-NA</b>	<b>NZM4-XHB-DAR-NA</b>
	<b>NZMH4-AEF1200-NA</b>	85	85	50								<b>NZM4-XHB-DA-NA</b>	<b>NZM4-XHB-DAR-NA</b>



# UL 489 Circuit Breaker and Molded Case Switch

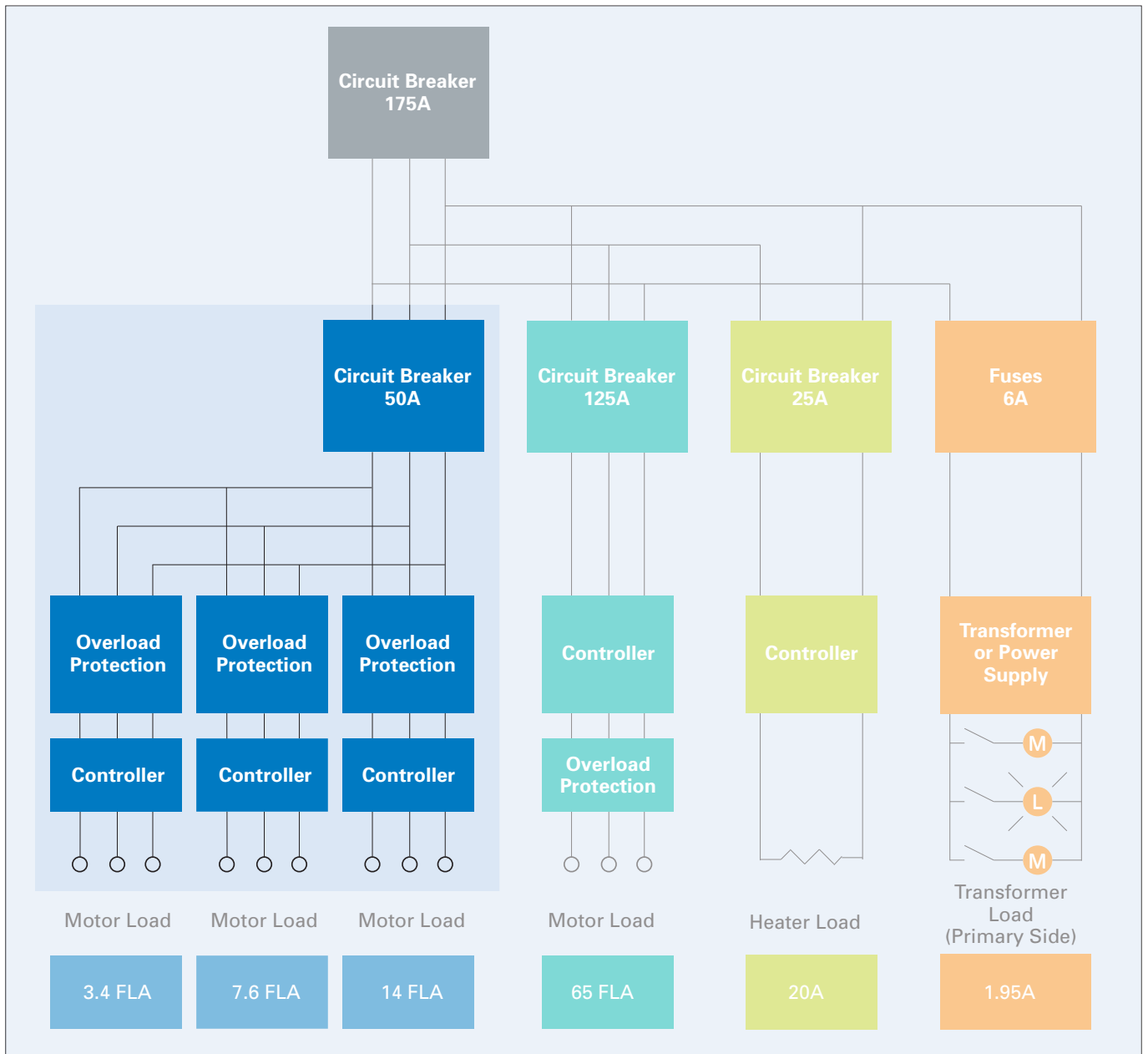
System overview



- |   |   |    |   |    |   |    |  |
|---|---|----|---|----|---|----|--|
| 1 | Switch-disconnector; circuit breaker; circuit breaker for North America; Molded case switches for North America | 5  | IP2X protection against contact with a finger | 13 | Standard auxiliary contacts, trip-indicating auxiliary switches | 19 | Rotary handle                                |
| 2 | IP2X protection against contact with a finger   | 6  | Tunnel terminals                              | 14 | Rear operator   | 20 | Remote operator                              |
| 3 | Terminal cover, knockout  | 7  | Box terminals                                 | 15 | Main switch rotary handle for side panel mounting               | 21 | Insulating surround                          |
| 4 | Terminal cover  | 8  | Control circuit terminal                      | 16 | Door coupling rotary handle                                     | 22 | External warning plate/ marking plate        |
|   |   | 9  | Connection width extension                    | 17 | Extension shaft   | 23 | Side operator handle                         |
|   |   | 10 | Adapter plate                                 | 18 |   | 24 | Mechanical interlock                         |
|   |   | 11 | Busbar adapter                                |    |   | 25 | Voltage release/Early-make auxiliary contact |
|   |   | 12 | Spacer  |    |   |    |  |

# Group motor design

Reference to UL 508A Section 31.4.1.c



**Group Motor – Multiple Motors Protected by a Single Set of Fuses or Breaker**

**The following rules apply to manual motor controllers for motor loads only:**

A single set of fuses or breaker can be used if the following conditions are met:

1. All power circuit devices are rated for group motor use as indicated on the component, heater tables or instruction publication.
2. The following tap rule (31.4.3) is met:
  - a. The conductors to the individual loads are not less than 1/10 the ampacity of the branch circuit protection for each circuit provided with a manual motor controller (MMC) marked "Suitable as tap conductor protection in group installations." Also, the conductors on the load side of the MMC shall not have an ampacity less than 125% of the motor FLA.
  1. The branch circuit protection is sized by the sum of the following:
    - a. If the branch protection is a breaker, 250% of the largest motor FLA, plus the sum of the remaining motor loads,
    - b. If the branch protection is a time delay fuse, 175% of the largest motor FLA, plus the sum of the remaining motor loads, or
    - c. If the branch protection is a CC fuse, 300% of the largest motor FLA, plus the sum of the remaining motor loads.
  2. The branch circuit protection must not exceed the amp rating as specified in the group installation marking of the power circuit components and the type specified.



PKE Manuel Motor Protector



MSC Manuel Motor Controller



## Special considerations for Manual Motor Controllers and Motor Starters in North America



Whitepaper download:  
[www.eaton.eu/publications](http://www.eaton.eu/publications)

The motor protection is described in detail in NEC Article 430.

Basically for all motor circuits the 4 functions are required:

- Disconnect (main switch)
- Short-circuit protection
- Operational switching (contactor)
- Overload protection.

This functions can separately incorporate equipment or might be combined in one device.

## Short Circuit Current Ratings for single protection, group protection, tap conductor protectors

Overload trip (A)	Accessories	SCCR		Fuse max.		Circuit breaker max.		Part no.
		(kA)	(kA)	(A)	(A)	(A)	(A)	
<b>1. Manual motor controller in group installations with upstream back-up protective device</b>		<b>480 V</b>	<b>600 V</b>	<b>480 V</b>	<b>600 V</b>	<b>480 V</b>	<b>600 V</b>	
0,1 - 6,3	-	50	50	600	600	600	600	PKZM0-...
6,3 - 11	-	30	30	600	600	600	600	PKZM0-10
9 - 12	-	65	18	600	600	600	600	PKZM0-...
10 - 16	-	10	10	150	150	125	125	PKZM0-...
10 - 16	with CL-PKZO	50	50	600	600	600	600	PKZM0-...
16 - 25	-	10	10	150	150	125	125	PKZM0-...
16 - 25	with CL-PKZO	18	18	600	600	600	600	PKZM0-...
24 - 32	-	18	10	600	600	150	125	PKZM0-...
24 - 32	with CL-PKZO	18	18	600	600	600	600	PKZM0-...
up to 52	-	65	42	600	600	600	600	PKZM4-50
up to 56	-	65	42	600	600	600	600	PKZM4-58
up to 58	-	65	42	600	600	600	600	PKZM4-63
<b>2. Tap Conductor Protectors suitable for use in group installations</b>		<b>480 Y/277 V*</b>	<b>600 Y/347 V*</b>	The maximum rating of the branch circuit protective fuse or circuit breaker is determined per the 1/10th rule.				
up to 11	-	50	50					PKZM0-...
up to 16	-	42	18					PKZM0-...
up to 32	-	18	-					PKZM0-...
up to 40	-	65	25					PKZM4-...
up to 58	-	65	-					PKZM4-...



\* solidly grounded system Status: April 2016

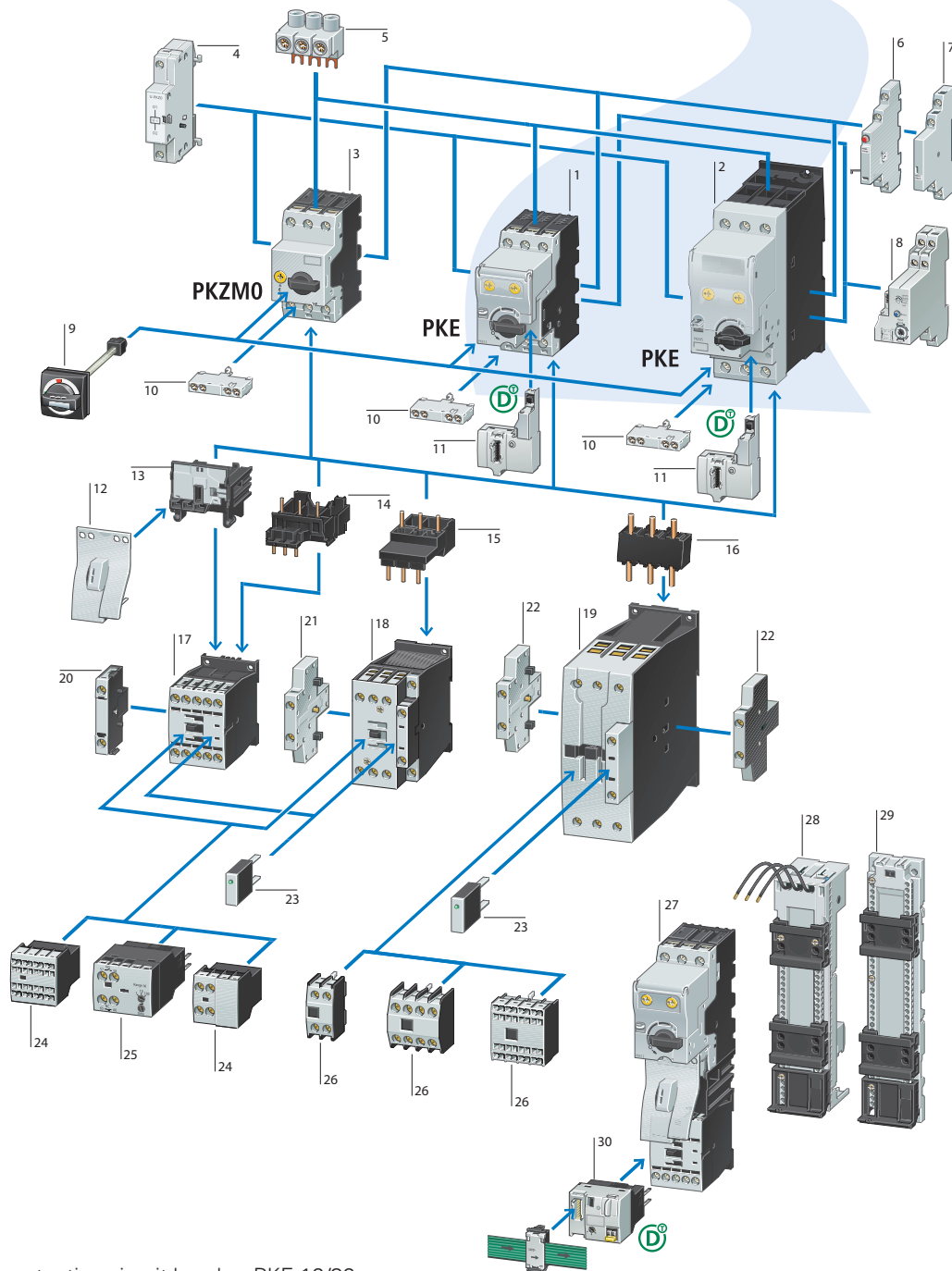
UL 508 Type E and UL 508 Type F controllers see on page 16 and 17.

Maximum short circuit current rating and sizing of back-up overcurrent protective fuses and circuit breakers in group installations per NEC, Article 430-53 and CEC Part 1, Rule 28-206. PKZM0 with and without CL-PKZM0 current limiter.

## Group Protection and Tap Conductor Protection Ratings PKE

Maximum motor rating Three-phase current				Setting Ranges overload release	Short-Circuit Current Rating (SCCR)			Group Protection and Tap Conductor Protection Fuse	Manual Motor Protector Part no.
200V HP	230V HP	460V HP	575V HP		240V kA	480V kA	600V kA		
		½	½	0,3 – 1,2	100	100	100	100A Class J	PKE12/XTU(A)-1,2
¾	¾	2	3	1 – 4	100	100	100	100A Class J	PKE12/XTU(A)-4
3	3	7½	10	3 – 12	100	100	100	100A Class J	PKE12/XTU(A)-12
5	7½	15	20	8 – 32	100	100	100	100A Class J	PKE32/XTU(A)-32
7½	7½	20	25	8 – 32	100	100	100	200A Class J	PKE65/XTU(A)W-32
15	15	40	40	16 – 65	100	100	100	200A Class J	PKE65/XTU(A)-65

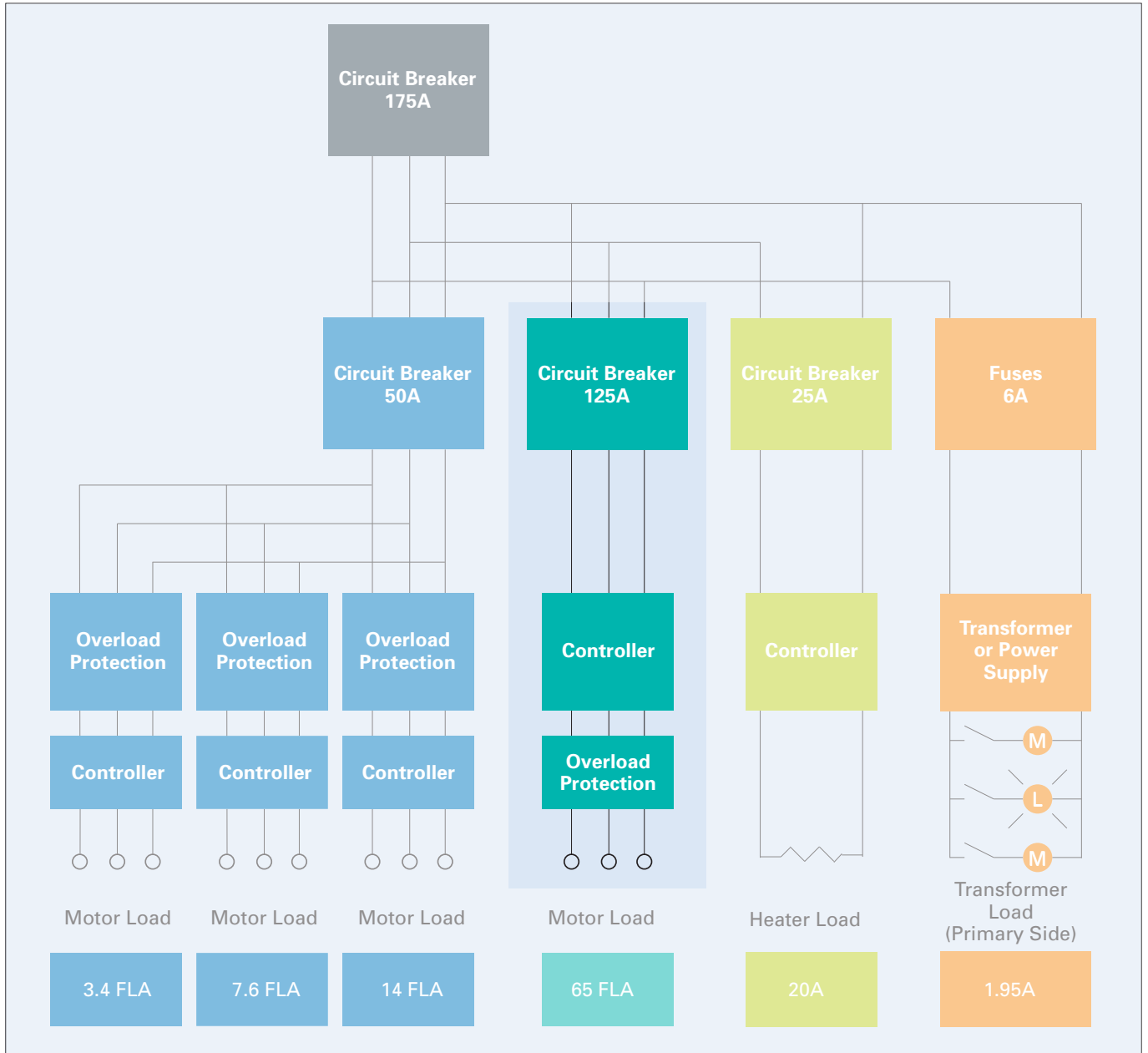




- |    |   |    |   |
|----|---|----|---|
| 1  | Motor-protective circuit breaker PKE 12/32      | 17 | Contactor up to 15 A                      |
| 2  | Motor-protective circuit breaker PKE 65         | 18 | Contactor up to 38 A                      |
| 3  | Motor-protective circuit breaker PKZM01         | 19 | Contactor up to 65 A                      |
| 4  | Undervoltage release/shunt release              | 20 | Side mounted auxiliary contact            |
| 5  | Feeder terminal block                           | 21 | Side mounted auxiliary contact            |
| 6  | Trip-indicating auxiliary contact               | 22 | Side mounted auxiliary contact            |
| 7  | Side mounted auxiliary contact                  | 23 | Suppressor                                |
| 8  | PKE-XZMR electronic overload relay module       | 24 | Surface mounted auxiliary contact         |
| 9  | Door-coupling rotary handle and shaft extension | 25 | Electronic timer                          |
| 10 | Front mounted auxiliary contact                 | 26 | Surface mounted auxiliary contact         |
| 11 | SmartWire-DT communication interface for PKE    | 27 | DOL starter MSC-DEA up to 5.5 kW with PKE |
| 12 | Combination plug-in connector                   | 28 | Busbar adapter                            |
| 13 | Mechanical plug-in connector                    | 29 | DIN rail adapter plate                    |
| 14 | Motor starter link                              | 30 | SmartWire-DT PKE module                   |
| 15 | Electrical plug-in connector                    |    |   |
| 16 | Electrical plug-in connector                    |    |   |

# Individual circuit for motor load

Reference to UL 508A Section 31.3, 33.2, 34.2, 66.8



**Individual Circuit for Motor Load**

There are several ways to build a branch circuit for a motor load. Each method provides short-circuit protection, motor overload protection, and the ability to start and stop the motor. Some additionally provide a means to disconnect the branch circuit for maintenance and safety purposes.

UL 508 Type F Combination Motor Controllers (CMCs) (manual motor protector + contactor + line-side adapter) provide the most efficient means to build a branch circuit for a motor. CMCs are designed for motor loads such that they do not need to be oversized (as breakers and fuses are) to prevent tripping during motor startup. CMCs not only take up less space, but also install more quickly.



UL 508 Type E/F combination motor controllers (MSC) are self-protected and do not limit the upstream protective devices.

## 2-Component Combination Motor Controller Solutions for North America



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Motors are by far the most important pieces of equipment in the machine tool and panel building industry. There are essentially 2 traditional approaches involved in switching and protecting such motors. One uses fuses as the primary overcurrent protective device. The other is fuseless, and relies on motor protective switches or circuit breakers as the core protective element.

In the IEC world, the choice between a motor protective switch or a circuit breaker can often be made simply on the basis of a motor's nominal current rating. In North America, both types of components fall under markedly different product standards (UL 508 resp. UL 489, or CSA-C22.2 No.14 resp. CSA-C22.2 No. 5-09), which ultimately also impacts the application range of both components when they are used as protective devices in branch circuits.

# Branch Circuit Protection: PKZM0(4), UL 508 Type E “Manual self-protected combination motor controllers”

Maximum Motor HP Rating 3 Phase, 60Hz				Trip settings		Short Circuit Current Rating (SCCR)			Components	
200 V 208 V (HP)	230 V 240 V (HP)	460V 480 V (HP)	575 V 600 V (HP)	Adjustable thermal (A)	Instantaneous Trip, Fixed (A)	240 V (kA)	480V/277 V <sup>2)</sup> (kA)	600Y/347V <sup>2)</sup> (kA)	Motor Protector Part no.	Accessories Part no.
1)				0.1 - 0.16	2.5	65	65	50	PKZM0-0,16	BK25/3-PKZ0-E
				0.16 - 0.25	3.9	65	65	50	PKZM0-0,25	BK25/3-PKZ0-E
				0.25 - 0.4	6.2	65	65	50	PKZM0-0,4	BK25/3-PKZ0-E
				0.4 - 0.63	9.8	65	65	50	PKZM0-0,63	BK25/3-PKZ0-E
				0.63 - 1	16	65	65	50	PKZM0-1	BK25/3-PKZ0-E
				1 - 1.6	25	65	65	50	PKZM0-1,6	BK25/3-PKZ0-E
½	½	1	1 ½	1.6 - 2.5	39	65	65	50	PKZM0-2,5	BK25/3-PKZ0-E
¾	¾	2	3	2.5 - 4	62	65	65	50	PKZM0-4	BK25/3-PKZ0-E
1 ½	1 ½	3	5	4 - 6.3	98	65	65	50	PKZM0-6,3	BK25/3-PKZ0-E
2	3	5	7 ½	6.3 - 11	155	65	65	50	PKZM0-10	BK25/3-PKZ0-E
3	3	7 ½	10	9 - 12	186	65	65	18	PKZM0-12	BK25/3-PKZ0-E
3	5	10	-	10 - 16	248	42	42	-	PKZM0-16	BK25/3-PKZ0-E
5	-	-	-	16 - 20	310	18	18	-	PKZM0-20	BK25/3-PKZ0-E
-	7 ½	15	-	20 - 25	388	18	18	-	PKZM0-25	BK25/3-PKZ0-E
7 ½	10	20	-	24 - 32	496	18	18	-	PKZM0-32	BK25/3-PKZ0-E
3	5	10	10	10 - 16	248	65	65	25	PKZM4-16	BK50/3-PKZ4-E
5	7 ½	15	20	16 - 27	388	65	65	25	PKZM4-25	BK50/3-PKZ4-E
7 ½	10	20	30	24 - 34	496	65	65	25	PKZM4-32	BK50/3-PKZ4-E
10	-	30	30	32 - 40	620	65	65	25	PKZM4-40	BK50/3-PKZ4-E
-	15	30	-	40 - 52	775	65	65	-	PKZM4-50	BK50/3-PKZ4-E
-	-	40	-	50 - 56	899	65	65	-	PKZM4-58	BK50/3-PKZ4-E
-	-	40	-	52 - 58	977	65	65	-	PKZM4-63	BK50/3-PKZ4-E

1) In this range, select devices per motor full load current. Refer to NEC Table 430-250.  
2) Solidly grounded power distribution system.

Status: April 2016

## UL 508 Type E “Manual self-protected combination motor controllers”





## Branch Circuit Protection: PKZM0(4), “UL 508 Type F Combination Motor Controllers”

Maximum Motor HP Rating 3 Phase, 60Hz				Trip settings		Short Circuit Current Rating (SCCR)			Components		
200 V 208 V (HP)	230 V 240 V (HP)	460V 480 V (HP)	575 V 600 V (HP)	Adjustable thermal (A)	Instantaneous Trip, Fixed (A)	240 V (kA)	480Y/ 277 V <sup>2)</sup> (kA)	600Y/ 347V <sup>2)</sup> (kA)	Motor Protector Part no.	Supply Terminal Part no.	Contactore Part no.
1)				0.1 - 0.16	2.5	50	50	50	PKZM0-0,16	BK25/3-PKZ0-E	DILEM
				0.16 - 0.25	3.9	50	50	50	PKZM0-0,25	BK25/3-PKZ0-E	DILEM
				0.25 - 0.4	6.2	50	50	50	PKZM0-0,4	BK25/3-PKZ0-E	DILEM
				0.4 - 0.63	9.8	50	50	50	PKZM0-0,63	BK25/3-PKZ0-E	DILEM
				0.63 - 1	16	50	50	50	PKZM0-1	BK25/3-PKZ0-E	DILEM
		¾	¾	1 - 1.6	25	50	50	50	PKZM0-1,6	BK25/3-PKZ0-E	DILEM
½	½	1	1 ½	1.6 - 2.5	39	50	50	50	PKZM0-2,5	BK25/3-PKZ0-E	DILEM
¾	¾	2	3	2.5 - 4	62	50	50	50	PKZM0-4	BK25/3-PKZ0-E	DILEM
1	1 ½	3	5	4 - 6.3	98	50	50	50	PKZM0-6,3	BK25/3-PKZ0-E	DILEM
2	3	5	7 ½	6.3 - 11	155	50	50	50	PKZM0-10	BK25/3-PKZ0-E	DILEM
1)			-	0.1 - 0.16	2.5	65	65	18	PKZM0-0,16	BK25/3-PKZ0-E	DILM7
			-	0.16 - 0.25	3.9	65	65	18	PKZM0-0,25	BK25/3-PKZ0-E	DILM7
			-	0.25 - 0.4	6.2	65	65	18	PKZM0-0,4	BK25/3-PKZ0-E	DILM7
			-	0.4 - 0.63	9.8	65	65	18	PKZM0-0,63	BK25/3-PKZ0-E	DILM7
			-	0.63 - 1	16	65	65	18	PKZM0-1	BK25/3-PKZ0-E	DILM7
		¾	¾	1 - 1.6	25	65	65	18	PKZM0-1,6	BK25/3-PKZ0-E	DILM7
½	½	1	1 ½	1.6 - 2.5	39	65	65	18	PKZM0-2,5	BK25/3-PKZ0-E	DILM7
¾	¾	2	3	2.5 - 4	62	65	65	18	PKZM0-4	BK25/3-PKZ0-E	DILM7
1	1 ½	3	5	4 - 6.3	98	65	65	18	PKZM0-6,3	BK25/3-PKZ0-E	DILM7
2	3	5	7 ½	6.3 - 11	155	65	65	18	PKZM0-10	BK25/3-PKZ0-E	DILM12
3	3	7 ½	10	9 - 12	186	50	50	18	PKZM0-12	BK25/3-PKZ0-E	DILM12
3	5	10	-	10 - 16	248	18	18	-	PKZM0-16	BK25/3-PKZ0-E	DILM17
5	-	-	-	16 - 20	310	18	18	-	PKZM0-20	BK25/3-PKZ0-E	DILM25
-	7 ½	15	-	20 - 25	388	18	18	-	PKZM0-25	BK25/3-PKZ0-E	DILM25
7 ½	10	20	-	24 - 32	496	18	18	-	PKZM0-32	BK25/3-PKZ0-E	DILM32
3	5	10	10	10 - 16	248	65	65	50	PKZM4-16	BK50/3-PKZ4-E	DILM32
5	7 ½	15	20	16 - 27	388	65	65	50	PKZM4-25	BK50/3-PKZ4-E	DILM32
7 ½	10	20	30	24 - 34	496	65	65	50	PKZM4-32	BK50/3-PKZ4-E	DILM32
10	-	30	30	32 - 40	620	65	65	50	PKZM4-40	BK50/3-PKZ4-E	DILM40
-	15	30	-	40 - 52	775	65	65	-	PKZM4-50	BK50/3-PKZ4-E	DILM50
-	-	40	-	50 - 56	899	65	65	-	PKZM4-58	BK50/3-PKZ4-E	DILM65
-	-	40	-	52 - 58	977	65	65	-	PKZM4-63	BK50/3-PKZ4-E	DILM65

1) In this range, select motor protector per motor full load current. Refer to NEC Table 430-250.

2) Suitable for solidly grounded power distribution systems.

Stand: April 2016




### Motor-protective circuit breaker – UL 508 Typ F Combination Starters



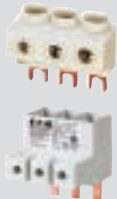




## Branch Circuit Protection; MSC-DE-...-M...-SP, “Type E Combination Motor Controller”

Maximum motor rating Three-phase current				Setting Ranges overload release	Rated short-circuit breaking capacity			Combination Motor Starter
200V HP	230V HP	460V HP	575V HP	A	240V kA	480Y/277V kA	600Y/347V kA	
		1/2	1/2	0,3–1,2	14	14	14	MSC-DE-1,2-M17-SP(...)
¾	¾	2	-	1–4	18	18	-	MSC-DE-4-M17-SP(...)
3	3	7 1/2	-	3–12	18	18	-	MSC-DE-12-M17-SP(...)
5	7 1/2	15	-	8–32	18	18	-	MSC-DE-32-M32-SP(...)

### MSC-DE-...-M...-SP, Type E Combination Motor Controller with PKE

# Branch Circuit Protection "Type E Combination Motor Controller"

460V HP	460V FLA	Motor Current Adjust Range (A)	Short Circuit Current Rating (SCCR) 480Y/277V kA	MMP	Part no. for Field Assembly  Contactor		
	---	0,16	0.1 ... 0.16	65	PKZM0-0.16	---	DILM7..15-..
	---	0,25	0.16 ... 0.25		PKZM0-0.25	---	DILM7..15-..
	---	0,40	0.25 ... 0.40		PKZM0-0.4	---	DILM7..15-..
	---	0,63	0.40 ... 0.63		PKZM0-0.63	---	DILM7..15-..
	---	1,0	0.63 ... 1.0		PKZM0-1	---	DILM7..15-..
	3/4	1,6	1.0 ... 1.6		PKZM0-1.6	---	DILM7..15-..
	1	2,5	1.6 ... 2.5		PKZM0-2.5	---	DILM7..15-..
	2	4,0	2.5 ... 4.0		PKZM0-4	---	DILM7..15-..
	3	6,3	4.0 ... 6.3	65	PKZM0-6.3	---	---
	7-1/2	10	6.3 ... 10		PKZM0-10	---	---
	7-1/2	12,0	8.0 ... 12		PKZM0-12	---	---
	10	16,0	10.0 ... 16		PKZM0-16	---	---
	10	16,0	16 ... 20	18	PKZM0-20	---	---
	15	16,0	16...25		PKZM0-25	---	---
	20	16,0	25...32		PKZM0-32	---	---
	10	16,0	10.0 ... 16.0	65	---	PKZM4-16	---
	15	25,0	16 ... 25		---	PKZM4-25	---
	20	32,0	24... 32		---	PKZM4-32	---
	30	40,0	32... 40		---	PKZM4-40	---
	30	50,0	40 ... 50		---	PKZM4-50	---
	40	52,0	50 ... 52		---	PKZM4-58	---


		Terminal Adapter	Terminal Adapter	Connection Module (optional)	Connection Module (optional)	Lockable handle (optional)
						
---	---	BK25/3-PKZ0-E	---	PKZM0-XDM15ME	PKZM0-XDM12	AK-PKZ0
---	---	BK25/3-PKZ0-E	---	PKZM0-XDM15ME	PKZM0-XDM12	AK-PKZ0
---	---	BK25/3-PKZ0-E	---	PKZM0-XDM15ME	PKZM0-XDM12	AK-PKZ0
---	---	BK25/3-PKZ0-E	---	PKZM0-XDM15ME	PKZM0-XDM12	AK-PKZ0
---	---	BK25/3-PKZ0-E	---	PKZM0-XDM15ME	PKZM0-XDM12	AK-PKZ0
---	---	BK25/3-PKZ0-E	---	PKZM0-XDM15ME	PKZM0-XDM12	AK-PKZ0
---	---	BK25/3-PKZ0-E	---	PKZM0-XDM15ME	PKZM0-XDM12	AK-PKZ0
---	---	BK25/3-PKZ0-E	---	PKZM0-XDM15ME	PKZM0-XDM12	AK-PKZ0
DILM17..32-..	---	BK25/3-PKZ0-E	---	PKZM0-XDM32	---	AK-PKZ0
DILM17..32-..	---	BK25/3-PKZ0-E	---	PKZM0-XDM32	---	AK-PKZ0
DILM17..32-..	---	BK25/3-PKZ0-E	---	PKZM0-XDM32	---	AK-PKZ0
DILM17..32-..	---	BK25/3-PKZ0-E	---	PKZM0-XDM32	---	AK-PKZ0
DILM25..32-..	---	BK25/3-PKZ0-E	---	PKZM0-XDM32	---	AK-PKZ0
DILM25..32-..	---	BK25/3-PKZ0-E	---	PKZM0-XDM32	---	AK-PKZ0
DILM32-..	---	BK25/3-PKZ0-E	---	PKZM0-XDM32	---	AK-PKZ0
---	DILM40..65-..	BK50/3-PKZ4-E	HB-PKZ4	PKZM4-XM65DE	---	AK-PKZ0
---	DILM40..65-..	BK50/3-PKZ4-E	HB-PKZ4	PKZM4-XM65DE	---	AK-PKZ0
---	DILM40..65-..	BK50/3-PKZ4-E	HB-PKZ4	PKZM4-XM65DE	---	AK-PKZ0
---	DILM40..65-..	BK50/3-PKZ4-E	HB-PKZ4	PKZM4-XM65DE	---	AK-PKZ0
---	DILM50..65-..	BK50/3-PKZ4-E	HB-PKZ4	PKZM4-XM65DE	---	AK-PKZ0
---	DILM65-..	BK50/3-PKZ4-E	HB-PKZ4	PKZM4-XM65DE	---	AK-PKZ0


Individual Circuit for Motor Load

# Branch Circuit Protection: UL 489 Circuit Breaker with UL 508 Motor Protection Calibration

$I_n = I_u$ (A)	Setting Range		Projected Max. HP Ratings	Breaker with Normal Interrupting rating <b>Part no.</b>	Breaker with High Interrupting rating <b>Part no.</b>	Suitable magnetic contactors <b>Part no.</b>
	Overload Trip* $I_t$ (A)	Instantaneous short circuit trip $I_i$ (A)				
			460 V 480 V HP	SCCR 85 kA 240 V 35 kA 480 V	SCCR 150 kA 240 V 100 kA 480 V	
90	45-90	90-1260	2 ... 14 x $I_n$	NZMN2-ME90-NA	NZMH2-ME90-NA	DILM80 DILM95
140	70-140	140-1960	2 ... 14 x $I_n$	NZMN2-ME140-NA	NZMH2-ME140-NA	DILM115 DILM150
200	100-200	200-2800	2 ... 14 x $I_n$	NZMN2-ME200-NA	NZMH2-ME200-NA	DILM185A DILM225A

## Branch circuit protection for variable speed starter

Nominal input current	Part no.	Branch Circuit Protection AWG wiring required Molded Case Circuit Breaker					
		1 pole: 277 V AC	2 poles: 480 Y/277 V AC	SCCR	Fuse	SCCR	
A				kA		kA	
 DE1/DE11	10	DE1-121D4...	FAZ-B10/1-NA	FAZ-B10/2-NA	10	LPJ-10SP	100
	10	DE1-122D3...	FAZ-B10/1-NA	FAZ-B10/2-NA	10	LPJ-10SP	100
	10	DE1-122D7...	FAZ-B10/1-NA	FAZ-B10/2-NA	10	LPJ-10SP	100
	15	DE1-124D3...	FAZ-B15/1-NA	FAZ-B15/2-NA	14	LPJ-15SP	100
	20	DE1-127D0...	FAZ-B20/1-NA	FAZ-B20/2-NA	14	LPJ-20SP	100
	30	DE1-129D6...	FAZ-B30/1-NA	FAZ-B30/2-NA	10	LPJ-30SP	100
	10	DE11-121D4...	FAZ-B10/1-NA	FAZ-B10/2-NA	10	LPJ-10SP	100
	10	DE11-122D3...	FAZ-B10/1-NA	FAZ-B10/2-NA	10	LPJ-10SP	100
	10	DE11-122D7...	FAZ-B10/1-NA	FAZ-B10/2-NA	10	LPJ-10SP	100
	15	DE11-124D3...	FAZ-B15/1-NA	FAZ-B15/2-NA	14	LPJ-15SP	100
	20	DE11-127D0...	FAZ-B20/1-NA	FAZ-B20/2-NA	14	LPJ-20SP	100
	30	DE11-129D6...	FAZ-B30/1-NA	FAZ-B30/2-NA	10	LPJ-30SP	100

Part no.	Branch Circuit Protection Combination Motor Controller Type E 3 poles: 480 Y/277 V AC	Branch- and Group-Protection Molded Case Circuit Breaker						
		SCCR	3 poles: 480 Y/277 V AC	SCCR	Fuse	SCCR		
A		kA		kA		kA		
 DE1/DE11	6	DE1-341D3...	PKZM0-6,3+BK25/3-PKZ0-E+AK-PKZ0	65	FAZ-B6/3-NA	10	LPJ-6SP	100
	6	DE1-342D1...	PKZM0-6,3+BK25/3-PKZ0-E+AK-PKZ0	65	FAZ-B6/3-NA	10	LPJ-6SP	100
	6	DE1-343D6...	PKZM0-6,3+BK25/3-PKZ0-E+AK-PKZ0	65	FAZ-B6/3-NA	10	LPJ-6SP	100
	10	DE1-345D0...	PKZM0-10+BK25/3-PKZ0-E+AK-PKZ0	65	FAZ-B10/3-NA	10	LPJ-10SP	100
	15	DE1-346D6...	PKZM0-16+BK25/3-PKZ0-E+AK-PKZ0	42	FAZ-B15/3-NA	14	LPJ-15SP	100
	15	DE1-348D5...	PKZM0-16+BK25/3-PKZ0-E+AK-PKZ0	42	FAZ-B15/3-NA	14	LPJ-15SP	100
	15	DE1-34011...	PKZM0-16+BK25/3-PKZ0-E+AK-PKZ0	42	FAZ-B15/3-NA	14	LPJ-15SP	100
	25	DE1-34016...	PKZM0-25+BK25/3-PKZ0-E+AK-PKZ0	18	FAZ-B25/3-NA	14	LPJ-25SP	100
	6	DE11-341D3...	PKZM0-6,3+BK25/3-PKZ0-E+AK-PKZ0	65	FAZ-B6/3-NA	10	LPJ-6SP	100
	6	DE11-342D1...	PKZM0-6,3+BK25/3-PKZ0-E+AK-PKZ0	65	FAZ-B6/3-NA	10	LPJ-6SP	100
	6	DE11-343D6...	PKZM0-6,3+BK25/3-PKZ0-E+AK-PKZ0	65	FAZ-B6/3-NA	10	LPJ-6SP	100
	10	DE11-345D0...	PKZM0-10+BK25/3-PKZ0-E+AK-PKZ0	65	FAZ-B10/3-NA	10	LPJ-10SP	100
	15	DE11-346D6...	PKZM0-16+BK25/3-PKZ0-E+AK-PKZ0	42	FAZ-B15/3-NA	14	LPJ-15SP	100
	15	DE11-348D5...	PKZM0-16+BK25/3-PKZ0-E+AK-PKZ0	42	FAZ-B15/3-NA	14	LPJ-15SP	100
	15	DE11-34011...	PKZM0-16+BK25/3-PKZ0-E+AK-PKZ0	42	FAZ-B15/3-NA	14	LPJ-15SP	100
	25	DE11-34016...	PKZM0-25+BK25/3-PKZ0-E+AK-PKZ0	18	FAZ-B25/3-NA	14	LPJ-25SP	100

# Branch Circuit Protection for drive circuits

Nominal Input Current	Part no.	FS	Supply Voltage	Nominal Supply Voltage	Branch Circuit Protection fuses	Fuse (Part no. J)	Fuse holders for LPJ fuse		
(without Main choke, CT, 50 oC)			(50 (-5 %) - 60 (+5 %) Hz)		UL	(UL: SCCR: 100 kA)			
A			V	V	A	A			
<b>Input Phase 1</b>									
7.8	DC1-1D2D3...	1	110 (-10 %) - 115 (+10 %)	110	10	LPJ-10SP	CH30J...		
15.8	DC1-1D4D3...	1			25	LPJ-25SP	CH30J...		
21.9	DC1-1D5D8...	2			30	LPJ-30SP	CH30J...		
3.7	DC1-122D3...	1	200 (-10 %) - 240 (+10 %)	230	6	LPJ-6SP	CH30J...		
7.5	DC1-124D3...	1			10	LPJ-10SP	CH30J...		
12.9	DC1-127D0...	1			17.5	LPJ-17-1-2SP	CH30J...		
12.9	DC1-127D0...	2			17.5	LPJ-17-1-2SP	CH30J...		
19.2	DC1-12011...	2			25	LPJ-25SP	CH30J...		
29.2	DC1-12015...	3			40	LPJ-40SP	CH60J...		
<b>Input Phase 3</b>									
3.4	DC1-322D3...	1			200 (-10 %) - 240 (+10 %)	230	6	LPJ-6SP	CH30J...
5.6	DC1-324D3...	1	10	LPJ-10SP			CH30J...		
9.5	DC1-327D0...	1	15	LPJ-15SP			CH30J...		
8.9	DC1-327D0...	2	15	LPJ-15SP			CH30J...		
12.1	DC1-32011...	2	17.5	LPJ-17-1-2SP			CH30J...		
20.9	DC1-32018...	3	30	LPJ-30SP			CH30J...		
26.4	DC1-32024...	3	35	LPJ-35SP			CH60J...		
33.3	DC1-32030...	4	45	LPJ-45SP			CH60J...		
50.1	DC1-32046...	4	70	LPJ-70SP			JM60100-...		
3.5	DC1-342D2...	1	380 (-10 %) - 480 (+10 %)	400/460			6	LPJ-6SP	CH30J...
5.6	DC1-344D1...	1			10	LPJ-10SP	CH30J...		
5.6	DC1-344D1...	2			10	LPJ-10SP	CH30J...		
7.5	DC1-345D8...	2			10	LPJ-10SP	CH30J...		
11.5	DC1-349D5...	2			15	LPJ-15SP	CH30J...		
17.2	DC1-34014...	2			25	LPJ-25SP	CH30J...		
21.2	DC1-34018...	3			30	LPJ-30SP	CH30J...		
27.5	DC1-34024...	3			35	LPJ-35SP	CH60J...		
34.2	DC1-34030...	3			45	LPJ-45SP	CH60J...		
44.1	DC1-34039...	3			60	LPJ-60SP	CH60J...		
51.9	DC1-34046...	3			70	LPJ-70SP	JM60100-...		
<b>Input Phase 1</b>									
8.6	DA1-124D3...	2			200 (-10 %) - 240 (+10 %)	230	15	LPJ-15SP	CH30J...
12.9	DA1-127D0...	2	20	LPJ-20SP			CH30J...		
19.2	DA1-12011...	2	25	LPJ-25SP			CH30J...		
<b>Input Phase 3</b>									
5.7	DA1-324D3...	2	200 (-10 %) - 240 (+10 %)	230	10	LPJ-10SP	CH30J...		
10.5	DA1-327D0...	2			15	LPJ-15SP	CH30J...		
13.2	DA1-32011...	2			17.5	LPJ-17-1-2SP	CH30J...		
20.9	DA1-32018...	3			30	LPJ-30SP	CH30J...		
26.4	DA1-32024...	3			40	LPJ-40SP	CH60J...		
26.9	DA1-32024...	4			40	LPJ-40SP	CH60J...		
33.3	DA1-32030...	4			50	LPJ-50SP	CH60J...		
50.1	DA1-32046...	4			70	LPJ-70SP	JM60100-...		
63.9	DA1-32061...	5			90	LPJ-90SP	JM60100-...		
74	DA1-32072...	5			110	LPJ-110SP	JM60200-...		
99.1	DA1-32090...	6			150	LPJ-150SP	JM60200-...		
121	DA1-32110...	6			175	LPJ-175SP	JM60200-...		
159.7	DA1-32150...	6			225	LPJ-225SP	JM60400-...		
187.5	DA1-32180...	6			250	LPJ-250SP	JM60400-...		
206.5	DA1-32202...	7			300	LPJ-300SP	JM60400-...		
255.5	DA1-32248...	7			350	LPJ-350SP	JM60400-...		



DC1



DA1

Individual Circuit for Motor Load

# Branch Circuit Protection for drive circuits

Nominal Input Current	Part no.	FS	Supply Voltage	Nominal Supply Voltage	Branch Circuit Protection fuses	Fuse (Part no. J)	Fuse holders for LPJ fuse
(without Main choke, CT, 50 oC)			(50 (-5 %) - 60 (+5 %) Hz)		UL	(UL: SCCR: 100 kA)	
A			V	V	A	A	
<b>Input Phase 3</b>							
3,5	DA1-342D2....	2	380 (-10 %) - 480 (+10 %)	400/460	6	LPJ-6SP	CH30J...
5,6	DA1-344D1...	2			10	LPJ-10SP	CH30J...
7,5	DA1-345D8...	2			10	LPJ-10SP	CH30J...
11,5	DA1-349D5...	2			15	LPJ-15SP	CH30J...
17,2	DA1-34014...	3			25	LPJ-25SP	CH30J...
21,8	DA1-34018...	3			30	LPJ-30SP	CH30J...
27,5	DA1-34024...	3			40	LPJ-40SP	CH60J...
28	DA1-34024...	4			40	LPJ-40SP	CH60J...
34,2	DA1-34030...	4			50	LPJ-50SP	CH60J...
44,1	DA1-34039...	4			60	LPJ-60SP	CH60J...
51,9	DA1-34046...	4			70	LPJ-70SP	JM60100-...
66,1	DA1-34061...	5			80	LPJ-80SP	JM60100-...
77,3	DA1-34072...	5			100	LPJ-100SP	JM60100-...
102,7	DA1-34090...	6			125	LPJ-125SP	JM60200-...
126,4	DA1-34110...	6			150	LPJ-150SP	JM60200-...
164,7	DA1-34150...	6			200	LPJ-200SP	JM60200-...
192,1	DA1-34180...	6			250	LPJ-250SP	JM60400-...
210,8	DA1-34202...	7			300	LPJ-300SP	JM60400-...
244,5	DA1-34240...	7			350	LPJ-350SP	JM60400-...
307,8	DA1-34302...	7			400	LPJ-400SP	JM60400-...
377,2	DA1-34370...	8	500	LPJ-500SP	JM60600-...		
458,7	DA1-34450...	8	600	LPJ-600SP	JM60600-...		
3,4	DA1-352D1...	2	500 (-10 %) - 600 (+10 %)	500/575	6	LPJ-6SP	CH30J...
4,2	DA1-353D1...	2			6	LPJ-6SP	CH30J...
4,9	DA1-354D1...	2			10	LPJ-10SP	CH30J...
8,6	DA1-356D5...	2			10	LPJ-10SP	CH30J...
12,2	DA1-359D0...	2			15	LPJ-15SP	CH30J...
15,1	DA1-35012...	3			20	LPJ-20SP	CH30J...
20,9	DA1-35017...	3			30	LPJ-30SP	CH30J...
25,5	DA1-35022...	3			35	LPJ-35SP	CH60J...
26	DA1-35022...	4			35	LPJ-35SP	CH60J...
32,2	DA1-35028...	4			45	LPJ-45SP	CH60J...
39,1	DA1-35034...	4			60	LPJ-60SP	CH60J...
48,9	DA1-35043...	4			70	LPJ-70SP	JM60100-...
59,5	DA1-35054...	5			80	LPJ-80SP	JM60100-...
70,4	DA1-35065...	5			100	LPJ-100SP	JM60100-...
90,6	DA1-35078...	6			125	LPJ-125SP	JM60200-...
121,1	DA1-35105...	6			150	LPJ-150SP	JM60200-...
143,2	DA1-35130...	6			175	LPJ-175SP	JM60200-...
158,4	DA1-35150...	6			200	LPJ-200SP	JM60200-...



DA1

Nominal Input Current	Part no.	FS	Supply Voltage	Nominal Supply Voltage	Branch Circuit Protection fuses	Fuse (Part no. J)	Fuse holders for LPJ fuse
(without Main choke, CT, 50 oC)			(50 (-5 %) - 60 (+5 %) Hz)		UL	(UL: SCCR: 100 kA)	
A			V	V	A	A	
<b>Input Phase 3</b>							
3,2	DG1-323D7...	1	208 (-15 %) - 240 (+10 %)	230	10	LPJ-10SP	CH30J...
4,4	DG1-324D8...	1			10	LPJ-10SP	CH30J...
6,1	DG1-326D6...	1			10	LPJ-10SP	CH30J...
7,2	DG1-327D8...	1			15	LPJ-15SP	CH30J...
10,2	DG1-32011...	1			15	LPJ-15SP	CH30J...
10,2	DG1-32012...	2			20	LPJ-20SP	CH30J...
16,2	DG1-32017...	2			30	LPJ-30SP	CH30J...
23,1	DG1-32025...	2			35	LPJ-35SP	CH60J...
28,7	DG1-32031...	3			60	LPJ-60SP	CH60J...
44,4	DG1-32048...	3			80	LPJ-80SP	JM60100-...
56,4	DG1-32061...	4			100	LPJ-100SP	JM60200-...
69,4	DG1-32075...	4			110	LPJ-110SP	JM60200-...
81,4	DG1-32088...	4			125	LPJ-125SP	JM60200-...
105,5	DG1-32114...	5			175	LPJ-175SP	JM60200-...
132,3	DG1-32143...	5			200	LPJ-200SP	JM60200-...
157,3	DG1-32170...	5	250	LPJ-250SP	JM60400-...		
2	DG1-342D2....	1	380 (-15 %) - 500 (+10 %)	400/460	10	LPJ-10SP	CH30J...
3,1	DG1-343D3...	1			10	LPJ-10SP	CH30J...
4	DG1-344D3...	1			10	LPJ-10SP	CH30J...
5,2	DG1-345D6...	1			10	LPJ-10SP	CH30J...
7,1	DG1-347D6...	1			15	LPJ-15SP	CH30J...
8,4	DG1-349D0...	1			15	LPJ-15SP	CH30J...
11,2	DG1-34012...	2			20	LPJ-20SP	CH30J...
15	DG1-34016...	2			30	LPJ-30SP	CH30J...
21,5	DG1-34023...	2			35	LPJ-35SP	CH60J...
29	DG1-34031...	3			50	LPJ-50SP	CH60J...
35,2	DG1-34038...	3			60	LPJ-60SP	CH60J...
42,6	DG1-34046...	3			80	LPJ-80SP	JM60100-...
55,7	DG1-34061...	4			100	LPJ-100SP	JM60100-...
65,7	DG1-34072...	4			110	LPJ-110SP	JM60200-...
79,4	DG1-34087...	4			125	LPJ-125SP	JM60200-...
97	DG1-34105...	5	175	LPJ-175SP	JM60200-...		
129	DG1-34140...	5	200	LPJ-200SP	JM60200-...		
157	DG1-34170...	5	250	LPJ-250SP	JM60400-...		
<b>Input Phase 3</b>							
	001A1-4...	4	380 (-15 %) - 500 (+10 %)	400/460	10	LPJ-10SP	CH30J...
	F15A1-4...	4			10	LPJ-10SP	CH30J...
	002A1-4...	4			10	LPJ-10SP	CH30J...
	003A1-4...	4			10	LPJ-10SP	CH30J...
	005A1-4...	4			10	LPJ-10SP	CH30J...
	006A1-4...	4			15	LPJ-15SP	CH30J...
	007A1-4...	5			20	LPJ-20SP	CH30J...
	010A1-4...	5			30	LPJ-30SP	CH30J...
	015A1-4...	5			35	LPJ-35SP	CH60J...
	020A1-4...	6			50	LPJ-50SP	CH60J...
	025A1-4...	6			50	LPJ-50SP	CH60J...
	030A1-4...	6			70	LPJ-70SP	JM60100-...
	040A1-4...	7			80	LPJ-80SP	JM60100-...
	050A1-4...	7			100	LPJ-100SP	JM60100-...
	060A1-4...	7			125	LPJ-125SP	JM60200-...
	075A1-4...	7			175	LPJ-175SP	JM60200-...
	100A1-4...	8			200	LPJ-200SP	JM60200-...
	125A1-4...	8			250	LPJ-250SP	JM60400-...
	150A1-4...	9			300	LPJ-300SP	JM60400-...
	200A1-4...	9			400	LPJ-400SP	JM60400-...



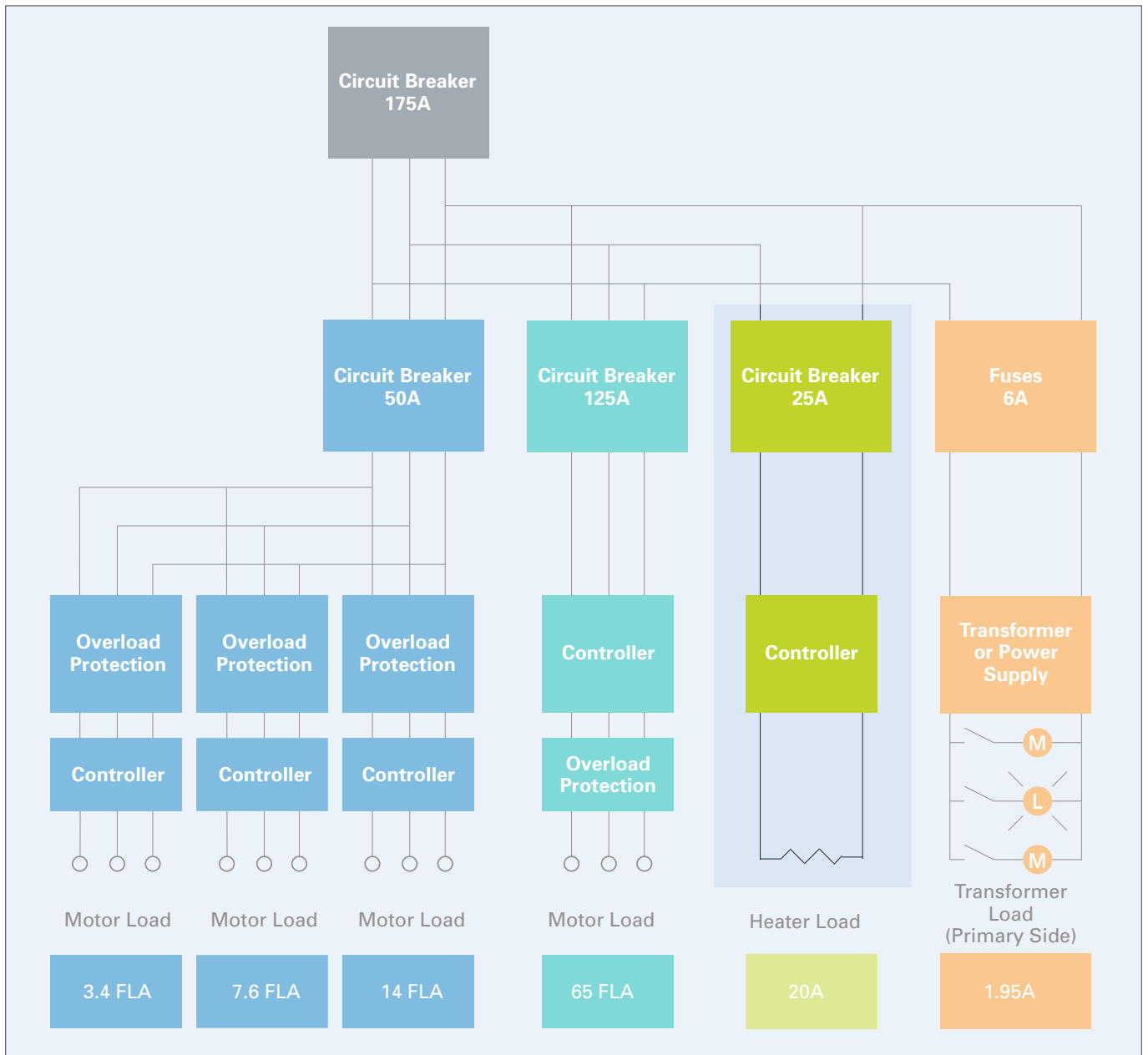
DG1



9000X

# Heater and lighting load circuits

Reference to UL 508A Sections 31.6, 31.8, 66.7.6



## Heater loads:

The branch circuit protection is sized (see Section 31.6.1 exceptions for larger heater loads):

1. Not less than 125 % of the heater load,
2. Not more than 60 A, and
3. Not larger than the ampacity of the field wiring to the heater load.

Controllers are sized to the heater full-load rating using the controller's general-purpose amp rating or resistive load rating.

## Lighting loads:

The branch circuit protection for standard-duty incandescent lampholders or fluorescent ballasts (see Section 31.8.2 for larger lighting loads):

1. Shall not exceed 20 A, and
2. Shall not exceed the ampacity of the anticipated field wiring

The controllers are sized to the specific lighting ratings.



## Branch Circuit Protection



Molded Case Circuit Breaker  
PKEM4-...-CB



Circuit Breaker FAZ...-NA



Fuse

## Controller



Contactor DILM

## Problem solver for the North American market: PKZM4-...-CB



Whitepaper download:  
[www.eaton.eu/publications](http://www.eaton.eu/publications)

Whereas electrical assemblies in the majority of countries around the world are primarily governed by IEC standards, the North American market is still largely the domain of local codes and standards (NEC, CEC, UL 508A, NFPA 79), which still markedly differ from the IEC standards in many aspects. Market conventions and customer sensibilities in North America also remain distinct and divergent in many ways from those encountered in the IEC world.

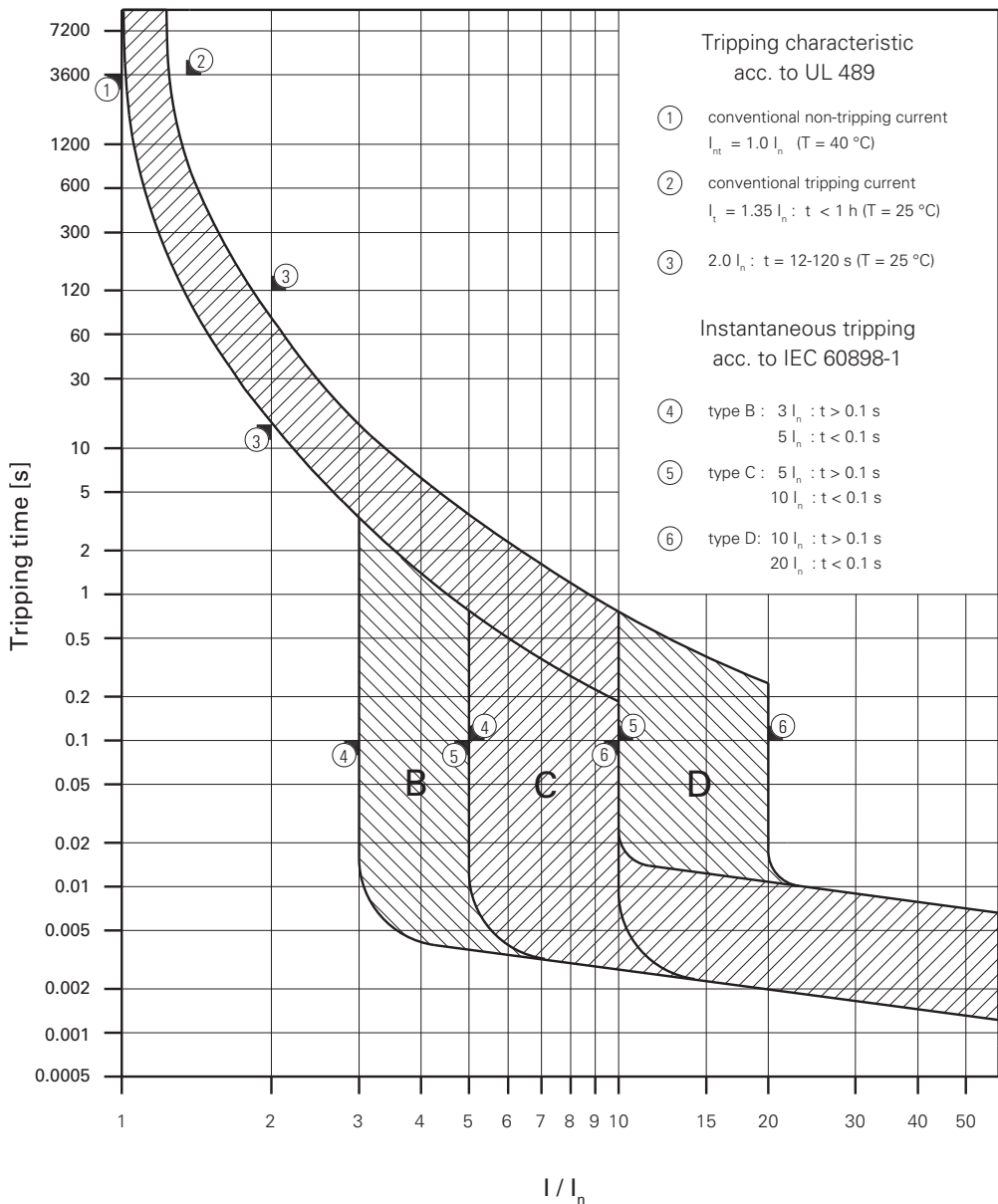
The most important load category involved in the design of electrical equipment for industrial machinery, both in the IEC world and in North America, are motors. Motors are switched and protected in various ways and the rules which outline the requirements in North America are well established and defined. The UL 508 standard recognizes various construction types of combination motor controllers for this purpose. Types E and F are especially relevant in the IEC world, since they legitimize the use of IEC style motor protective switches to a much greater extent.

# Branch circuit protection: PKZM4-CB



A	poles	Voltage (VAC)	Short Circuit Current in kA	Part no.
10...16	3	240	65	PKZM4-16-CB
16..25	3	240	65	PKZM4-25-CB
25...32	3	240	65	PKZM4-32-CB
10...16	3	480Y/277	65	PKZM4-16-CB
16..25	3	480Y/277	65	PKZM4-25-CB
25...32	3	480Y/277	65	PKZM4-32-CB
10...16	3	600Y/347	22	PKZM4-16-CB
16..25	3	600Y/347	22	PKZM4-25-CB
25...32	3	600Y/347	22	PKZM4-32-CB

## Characteristics of miniature circuit breakers



### Features:

- Current limiting design provides fast short-circuit interruption that reduces the let-through energy that can damage the circuit
- Thermal-magnetic overcurrent protection
- Three levels of short-circuit protection, Categorized by B, C and D curves
- Trip-free design. Breaker can not be defeated by holding the handle in the ON position
- A color-coded red/green indicator provides immediate visual indication of device status (green for OFF, red for ON) and isolation function.
- Power to the circuit breakers can be fed from the line or load side
- Separate version for ring-tongue connection (Type FAZ-RT), terminal screws can be removed (on both sides). Captive screws cannot be lost
- Fulfill UL 489, CSA C22.2 No.5 and also IEC 60947-2 Standard. For use in applications for which UL 1077 or CSA C22.2 No.235 are also allowed
- Easy installation on DIN rail. Module width of only 17.7 mm (per pole)
- To save installation time, bus connectors and feeder terminal facilitate mounting and wiring of multiple miniature circuit breaker arrays in control panel assemblies

Eaton offers a full range of DIN-Rail miniature circuit breakers up to 63A current rating for feeder and branch circuit protection. Breakers comply with the latest national and international standards including UL 489. Two levels of circuit




protection available, one for medium inrush startup currents to provide protection for small transformers, pilot devices, etc., and one with a magnetic range to allow for higher inrush levels during startup usually seen with motors.

# Branch circuit protection: circuit breaker xEffect FAZ-NA




Trip-curve B		Voltage (VAC)	Short circuit current in kA	Part no.		
A	Lift Terminal			Ring Tongue Terminal		
1 pole	1	277	10	FAZ-B1/1-NA	FAZ-B1/1-RT	
	1.5		10	FAZ-B1,5/1-NA	FAZ-B1,5/1-RT	
	2		10	FAZ-B2/1-NA	FAZ-B2/1-RT	
	3		10	FAZ-B3/1-NA	FAZ-B3/1-RT	
	4		10	FAZ-B4/1-NA	FAZ-B4/1-RT	
	5		10	FAZ-B5/1-NA	FAZ-B5/1-RT	
	6		10	FAZ-B6/1-NA	FAZ-B6/1-RT	
	7		10	FAZ-B7/1-NA	FAZ-B7/1-RT	
	8		10	FAZ-B8/1-NA	FAZ-B8/1-RT	
	10		10	FAZ-B10/1-NA	FAZ-B10/1-RT	
	13		10	FAZ-B13/1-NA	FAZ-B13/1-RT	
	15		14	FAZ-B15/1-NA	FAZ-B15/1-RT	
	16		14	FAZ-B16/1-NA	FAZ-B16/1-RT	
	20		14	FAZ-B20/1-NA	FAZ-B20/1-RT	
	25		14	FAZ-B25/1-NA	FAZ-B25/1-RT	
	30		10	FAZ-B30/1-NA	FAZ-B30/1-RT	
	32		10	FAZ-B32/1-NA	FAZ-B32/1-RT	
	35		240	10	FAZ-B35/1-NA	FAZ-B35/1-RT
	40			10	FAZ-B40/1-NA	FAZ-B40/1-RT
	50	5		FAZ-B50/1-NA	FAZ-B50/1-RT	
63	5	FAZ-B50/1-NA		FAZ-B50/1-RT		
2 poles	1	480Y/277	10	FAZ-B1/2-NA	FAZ-B1/2-RT	
	1.5		10	FAZ-B1,5/2-NA	FAZ-B1,5/2-RT	
	2		10	FAZ-B2/2-NA	FAZ-B2/2-RT	
	3		10	FAZ-B3/2-NA	FAZ-B3/2-RT	
	4		10	FAZ-B4/2-NA	FAZ-B4/2-RT	
	5		10	FAZ-B5/2-NA	FAZ-B5/2-RT	
	6		10	FAZ-B6/2-NA	FAZ-B6/2-RT	
	7		10	FAZ-B7/2-NA	FAZ-B7/2-RT	
	8		10	FAZ-B8/2-NA	FAZ-B8/2-RT	
	10		10	FAZ-B10/2-NA	FAZ-B10/2-RT	
	13		10	FAZ-B13/2-NA	FAZ-B13/2-RT	
	15		14	FAZ-B15/2-NA	FAZ-B15/2-RT	
	16		14	FAZ-B16/2-NA	FAZ-B16/2-RT	
	20		14	FAZ-B20/2-NA	FAZ-B20/2-RT	
	25		14	FAZ-B25/2-NA	FAZ-B25/2-RT	
	30		10	FAZ-B30/2-NA	FAZ-B30/2-RT	
	32		10	FAZ-B32/2-NA	FAZ-B32/2-RT	
	35		240	10	FAZ-B35/2-NA	FAZ-B35/2-RT
	40			10	FAZ-B40/2-NA	FAZ-B40/2-RT
	50	5		FAZ-B50/2-NA	FAZ-B50/2-RT	
63	5	FAZ-B63/2-NA		FAZ-B63/2-RT		
3 poles	1	480Y/277	10	FAZ-B1/3-NA	FAZ-B1/3-RT	
	1.5		10	FAZ-B1,5/3-NA	FAZ-B1,5/3-RT	
	2		10	FAZ-B2/3-NA	FAZ-B2/3-RT	
	3		10	FAZ-B3/3-NA	FAZ-B3/3-RT	
	4		10	FAZ-B4/3-NA	FAZ-B4/3-RT	
	5		10	FAZ-B5/3-NA	FAZ-B5/3-RT	
	6		10	FAZ-B6/3-NA	FAZ-B6/3-RT	
	7		10	FAZ-B7/3-NA	FAZ-B7/3-RT	
	8		10	FAZ-B8/3-NA	FAZ-B8/3-RT	
	10		10	FAZ-B10/3-NA	FAZ-B10/3-RT	
	13		10	FAZ-B13/3-NA	FAZ-B13/3-RT	
	15		14	FAZ-B15/3-NA	FAZ-B15/3-RT	
	16		14	FAZ-B16/3-NA	FAZ-B16/3-RT	
	20		14	FAZ-B20/3-NA	FAZ-B20/3-RT	
	25		14	FAZ-B25/3-NA	FAZ-B25/3-RT	
	30		10	FAZ-B30/3-NA	FAZ-B30/3-RT	
	32		10	FAZ-B32/3-NA	FAZ-B32/3-RT	
	35		240	10	FAZ-B35/3-NA	FAZ-B35/3-RT
	40			10	FAZ-B40/3-NA	FAZ-B40/3-RT
	50	5		FAZ-B50/3-NA	FAZ-B50/3-RT	
63	5	FAZ-B63/3-NA		FAZ-B63/3-RT		



Heater or Lighting Load

Trip-curve C		Voltage (VAC)	Short circuit current in kA	Part no.			
	A			Lift Terminal	Ringe Tongue Terminal		
	0.5	277	10	FAZ-C0,5/1-NA	FAZ-C0,5/1-RT		
	1		10	FAZ-C1/1-NA	FAZ-C1/1-RT		
	1.5		10	FAZ-C1,5/1-NA	FAZ-C1,5/1-RT		
	2		10	FAZ-C2/1-NA	FAZ-C2/1-RT		
	3		10	FAZ-C3/1-NA	FAZ-C3/1-RT		
	4		10	FAZ-C4/1-NA	FAZ-C4/1-RT		
	5		10	FAZ-C5/1-NA	FAZ-C5/1-RT		
	6		10	FAZ-C6/1-NA	FAZ-C6/1-RT		
	7		10	FAZ-C7/1-NA	FAZ-C7/1-RT		
	8		10	FAZ-C8/1-NA	FAZ-C8/1-RT		
	10		10	FAZ-C10/1-NA	FAZ-C10/1-RT		
	13		10	FAZ-C13/1-NA	FAZ-C13/1-RT		
	15		14	FAZ-C15/1-NA	FAZ-C15/1-RT		
	16		14	FAZ-C16/1-NA	FAZ-C16/1-RT		
	20		14	FAZ-C20/1-NA	FAZ-C20/1-RT		
	25		14	FAZ-C25/1-NA	FAZ-C25/1-RT		
	30		10	FAZ-C30/1-NA	FAZ-C30/1-RT		
	32		10	FAZ-C32/1-NA	FAZ-C32/1-RT		
	35		10	FAZ-C35/1-NA	FAZ-C35/1-RT		
	40		10	FAZ-C40/1-NA	FAZ-C40/1-RT		
	50		5	FAZ-C50/1-NA	FAZ-C50/1-RT		
	63		5	FAZ-C63/1-NA	FAZ-C63/1-RT		
			0.5	480Y/277	10	FAZ-C0,5/2-NA	FAZ-C0,5/2-RT
			1		10	FAZ-C1/2-NA	FAZ-C1/2-RT
			1.5		10	FAZ-C1,5/2-NA	FAZ-C1,5/2-RT
			2		10	FAZ-C2/2-NA	FAZ-C2/2-RT
			3		10	FAZ-C3/2-NA	FAZ-C3/2-RT
4		10	FAZ-C4/2-NA		FAZ-C4/2-RT		
5		10	FAZ-C5/2-NA		FAZ-C5/2-RT		
6		10	FAZ-C6/2-NA		FAZ-C6/2-RT		
7		10	FAZ-C7/2-NA		FAZ-C7/2-RT		
8		10	FAZ-C8/2-NA		FAZ-C8/2-RT		
10		10	FAZ-C10/2-NA		FAZ-C10/2-RT		
13		10	FAZ-C13/2-NA		FAZ-C13/2-RT		
15		14	FAZ-C15/2-NA		FAZ-C15/2-RT		
16		14	FAZ-C16/2-NA		FAZ-C16/2-RT		
20		14	FAZ-C20/2-NA		FAZ-C20/2-RT		
25		14	FAZ-C25/2-NA		FAZ-C25/2-RT		
30		10	FAZ-C30/2-NA		FAZ-C30/2-RT		
32		10	FAZ-C32/2-NA		FAZ-C32/2-RT		
35		10	FAZ-C35/2-NA		FAZ-C35/2-RT		
40		10	FAZ-C40/2-NA		FAZ-C40/2-RT		
50		5	FAZ-C50/2-NA		FAZ-C50/2-RT		
63		5	FAZ-C63/2-NA		FAZ-C63/2-RT		
		0.5	480Y/277		10	FAZ-C0,5/3-NA	FAZ-C0,5/3-RT
		1			10	FAZ-C1/3-NA	FAZ-C1/3-RT
		1.5			10	FAZ-C1,5/3-NA	FAZ-C1,5/3-RT
		2			10	FAZ-C2/3-NA	FAZ-C2/3-RT
		3			10	FAZ-C3/3-NA	FAZ-C3/3-RT
	4	10		FAZ-C4/3-NA	FAZ-C4/3-RT		
	5	10		FAZ-C5/3-NA	FAZ-C5/3-RT		
	6	10		FAZ-C6/3-NA	FAZ-C6/3-RT		
	7	10		FAZ-C7/3-NA	FAZ-C7/3-RT		
	8	10		FAZ-C8/3-NA	FAZ-C8/3-RT		
	10	10		FAZ-C10/3-NA	FAZ-C10/3-RT		
	13	10		FAZ-C13/3-NA	FAZ-C13/3-RT		
	15	14		FAZ-C15/3-NA	FAZ-C15/3-RT		
	16	14		FAZ-C16/3-NA	FAZ-C16/3-RT		
	20	14		FAZ-C20/3-NA	FAZ-C20/3-RT		
	25	14		FAZ-C25/3-NA	FAZ-C25/3-RT		
	30	10		FAZ-C30/3-NA	FAZ-C30/3-RT		
	32	10		FAZ-C32/3-NA	FAZ-C32/3-RT		
	35	10		FAZ-C35/3-NA	FAZ-C35/3-RT		
	40	10		FAZ-C40/3-NA	FAZ-C40/3-RT		
	50	5		FAZ-C50/3-NA	FAZ-C50/3-RT		
	63	5		FAZ-C63/3-NA	FAZ-C63/3-RT		

**Trip-curve D**

	A	Voltage (VAC)	Short circuit current in kA	Part no. Lift Terminal	Ring Tongue Terminal	
	0.5	277	10	FAZ-D0,5/1-NA	FAZ-D0,5/1-RT	
	1		10	FAZ-D1/1-NA	FAZ-D1/1-RT	
	1.5		10	FAZ-D1,5/1-NA	FAZ-D1,5/1-RT	
	2		10	FAZ-D2/1-NA	FAZ-D2/1-RT	
	3		10	FAZ-D3/1-NA	FAZ-D3/1-RT	
	4		10	FAZ-D4/1-NA	FAZ-D4/1-RT	
	5		10	FAZ-D5/1-NA	FAZ-D5/1-RT	
	6		10	FAZ-D6/1-NA	FAZ-D6/1-RT	
	7		10	FAZ-D7/1-NA	FAZ-D7/1-RT	
	8		10	FAZ-D8/1-NA	FAZ-D8/1-RT	
	10		10	FAZ-D10/1-NA	FAZ-D10/1-RT	
	13		14	FAZ-D13/1-NA	FAZ-D13/1-RT	
	15		14	FAZ-D15/1-NA	FAZ-D15/1-RT	
	16		14	FAZ-D16/1-NA	FAZ-D16/1-RT	
	20		14	FAZ-D20/1-NA	FAZ-D20/1-RT	
	25		10	FAZ-D25/1-NA	FAZ-D25/1-RT	
	30		10	FAZ-D30/1-NA	FAZ-D30/1-RT	
	32		10	FAZ-D32/1-NA	FAZ-D32/1-RT	
	35		240	10	FAZ-D35/1-NA	FAZ-D35/1-RT
	40			10	FAZ-D40/1-NA	FAZ-D40/1-RT
	0.5	480Y/277	10	FAZ-D0,5/2-NA	FAZ-D0,5/2-RT	
	1		10	FAZ-D1/2-NA	FAZ-D1/2-RT	
	1.5		10	FAZ-D1,5/2-NA	FAZ-D1,5/2-RT	
	2		10	FAZ-D2/2-NA	FAZ-D2/2-RT	
	3		10	FAZ-D3/2-NA	FAZ-D3/2-RT	
	4		10	FAZ-D4/2-NA	FAZ-D4/2-RT	
	5		10	FAZ-D5/2-NA	FAZ-D5/2-RT	
	6		10	FAZ-D6/2-NA	FAZ-D6/2-RT	
	7		10	FAZ-D7/2-NA	FAZ-D7/2-RT	
	8		10	FAZ-D8/2-NA	FAZ-D8/2-RT	
	10		10	FAZ-D10/2-NA	FAZ-D10/2-RT	
	13		14	FAZ-D13/2-NA	FAZ-D13/2-RT	
	15		14	FAZ-D15/2-NA	FAZ-D15/2-RT	
	16		14	FAZ-D16/2-NA	FAZ-D16/2-RT	
	20		14	FAZ-D20/2-NA	FAZ-D20/2-RT	
	25		10	FAZ-D25/2-NA	FAZ-D25/2-RT	
	30		10	FAZ-D30/2-NA	FAZ-D30/2-RT	
	32		10	FAZ-D32/2-NA	FAZ-D32/2-RT	
	35		240	10	FAZ-D35/2-NA	FAZ-D35/2-RT
	40			10	FAZ-D40/2-NA	FAZ-D40/2-RT
	0.5	480Y/277	10	FAZ-D0,5/3-NA	FAZ-D0,5/3-RT	
	1		10	FAZ-D1/3-NA	FAZ-D1/3-RT	
	1.5		10	FAZ-D1,5/3-NA	FAZ-D1,5/3-RT	
	2		10	FAZ-D2/3-NA	FAZ-D2/3-RT	
	3		10	FAZ-D3/3-NA	FAZ-D3/3-RT	
	4		10	FAZ-D4/3-NA	FAZ-D4/3-RT	
	5		10	FAZ-D5/3-NA	FAZ-D5/3-RT	
	6		10	FAZ-D6/3-NA	FAZ-D6/3-RT	
	7		10	FAZ-D7/3-NA	FAZ-D7/3-RT	
	8		10	FAZ-D8/3-NA	FAZ-D8/3-RT	
	10		10	FAZ-D10/3-NA	FAZ-D10/3-RT	
	13		14	FAZ-D13/3-NA	FAZ-D13/3-RT	
	15		14	FAZ-D15/3-NA	FAZ-D15/3-RT	
	16		14	FAZ-D16/3-NA	FAZ-D16/3-RT	
	20		14	FAZ-D20/3-NA	FAZ-D20/3-RT	
	25		10	FAZ-D25/3-NA	FAZ-D25/3-RT	
	30		10	FAZ-D30/3-NA	FAZ-D30/3-RT	
	32		10	FAZ-D32/3-NA	FAZ-D32/3-RT	
	35		240	10	FAZ-D35/3-NA	FAZ-D35/3-RT
	40			10	FAZ-D40/3-NA	FAZ-D40/3-RT

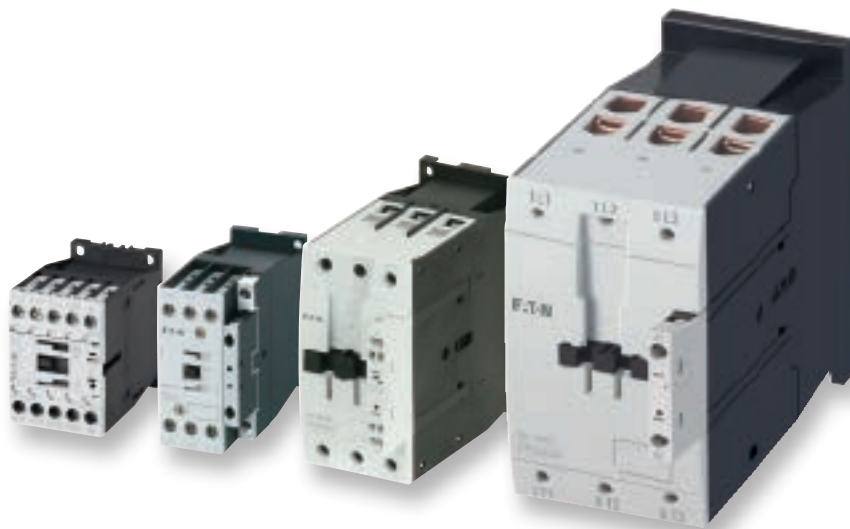
Heater or Lighting Load

## Special Purpose Ratings according to UL/CSA test conditions

Type DILM..	7	9	12	15	17	25	32	40	50	65 72	80	95	115	150 170
<b>AC Elevator Control</b>	HP	HP	HP	HP	HP	HP	HP	HP	HP	HP	HP	HP	HP	HP
480 V 60 Hz, 3-pole	2	3	7 ½	7 ½	7 ½	10	20	25	30	30	50	60	75	75
600 V 60 Hz, 3-pole	3	5	7 ½	7 ½	10	15	20	30	40	40	60	75	100	100
<b>AC Refrigeration Control</b>	A	A	A	A	A	A	A	A	A	A	A	A	A	A
480 V 60 Hz, 3-pole	6	7,5	10	10	23	32	40	26	36	45	63	70	84	90
600 V 60 Hz, 3-pole	6	7,5	10	10	17	24	30	26	36	45	63	70	84	90
<b>AC Resistance Air Heating</b>	A	A	A	A	A	A	A	A	A	A	A	A	A	A
480 V 60 Hz, 3-pole	12	18	20	20	27	35	40	63	79	90	94	110	136	160
600 V 60 Hz, 3-pole	12	18	20	20	27	35	40	63	79	90	94	110	136	160
<b>AC Incandescent Lamps (Tungsten)</b>	A	A	A	A	A	A	A	A	A	A	A	A	A	A
480 V 60 Hz, 3-pole	8	11	14	14	23	32	40	55	74	90	85	100	136	160
600 V 60 Hz, 3-pole	8	11	14	14	23	32	40	55	74	90	85	100	136	160
<b>AC Electrical Discharge Lamps (Ballast)</b>	A	A	A	A	A	A	A	A	A	A	A	A	A	A
480 V 60 Hz, 3-pole	12	18	20	20	27	35	40	63	79	90	85	100	136	160
600 V 60 Hz, 3-pole	12	18	20	20	27	35	40	63	79	90	85	100	136	160

Type DILK..	12	20	25	33	50
<b>Capacitive Switching</b>					
480 V 60 Hz, 3-pole, A	18	28	36	48	72.1
kVA <sub>r</sub>	15	20	30	40	60
600 V 60 Hz, 3-pole, A	14.4	28	38.4	48	72.1
kVA <sub>r</sub>	15	30	40	50	75

Selection table for contactors DILM and DILK for special Applications (Special Purpose Ratings) for the North America Market



Contactors Frame size 1 - 4

# Short Circuit Current Rating SCCR

Contactor	Basic Rating			480V High Fault				600V High Fault							
	kA	max. Fuse	max. CB	kA	max. Fuse	kA	max. CB	kA	max. Fuse	kA	max. CB				
DILM7-...(...)	5	45A	60A	30 / 100	25A / 20A Class J	65	16	30 / 100	25A / 20A Class J	-	Fuse Only				
DILM9-...(...)								65	16	30 / 100	25A / 20A Class J	-	Fuse Only		
DILM12-...(...)									-	Fuse Only	30 / 100	25A / 20A Class J	-	Fuse Only	
DILM15-...(...)									-	Fuse Only	30 / 100	25A / 20A Class J	-	Fuse Only	
DILMP20(...)							-	Fuse Only	30 / 100	25A / 20A Class J	-	Fuse Only			
DILM17-...(...)		125A	125A	125A	10 / 100	125A / 70A Class J	10 / 65	50A / 32A	10 / 100	125A / 70A Class J	10 / 22	50A / 32A			
DILM25-...(...)									10 / 65	50A / 32A	10 / 100	125A / 100A Class J	10 / 22	50A / 32A	
DILM32-...(...)										10 / 65	50A / 32A	10 / 100	125A / 125A Class J	10 / 22	50A / 32A
DILM38-...(...)										10 / 65	50A / 32A	10 / 100	125A / 125A Class J	10 / 22	50A / 32A
DILMP32-...(...)										10 / 65	50A / 32A	10 / 100	125A / 125A Class J	10 / 22	50A / 32A
DILMP45-...(...)										10 / 65	50A / 32A	10 / 100	125A / 125A Class J	10 / 22	50A / 32A
DILM40(...)	10				250A	250A	30 / 100		65	100A	30 / 100	125A / 125A Class J	30	250A	
DILM50(...)								65	100A	30 / 100	250A / 150A Class J	30	250A		
DILM65(...)									65	100A	30 / 100	250A / 150A Class J	30	250A	
DILM72(...)									65	100A	30 / 100	250A / 150A Class J	30	250A	
DILMP63(...)							65	100A	30 / 100	250A / 150A Class J	30	250A			
DILMP80(...)							65	100A	30 / 100	250A / 150A Class J	30	250A			
DILM80(...)		600A	600A	600A		300A / 300A Class J	65	250A	30 / 100	300A / 300A Class J	30	350A			
DILM95(...)									65	250A	30 / 100	300A / 300A Class J	30	350A	
DILM115(...)										65	250A	30 / 100	300A / 300A Class J	30	350A
DILM150(...)										65	250A	30 / 100	300A / 600A Class J	30	350A
DILM170(...)										65	250A	30 / 100	300A / 600A Class J	30	350A
DILMP125(...)									65	250A	30 / 100	300A / 600A Class J	30	350A	
DILMP160(...)									65	250A	30 / 100	300A / 600A Class J	30	350A	
DILMP200(...)						65	250A	30 / 100	300A / 600A Class J	30	350A				
DILM185A(...)	700A	800A	100	600A Class J	65	350A	100	600A Class J	50	350A					
DILM225A(...)		600A			65	350A	100	600A Class J	50	350A					
DILM250(...)	18		18	700A Class L	65	250A	18	700A Class J	18	600A					
DILM300A(...)						65	250A	18	700A Class J	18	600A				
DILM400(...)	30	800A		30 / 100	800A / 600A Class J	100	600A	30	800A	30	600A				
DILM500(...)							100	600A	30	800A	30	600A			
DILM570(...)							100	600A	30	800A	30	600A			
DILM580(...)		2000A	1200A	85	2000A		85	1200A	85	2000A	85	1200A			
DILM650(...)										85	1200A	85	2000A	85	1200A
DILM750(...)											85	1200A	85	2000A	85
DILM820(...)	42					85	1200A	85	2000A	85	1200A				
DILM1000(...)	85					85	1200A	85	2000A	85	1200A				
DILM1600(...)						-	-	85	2000A	-	-				

Heater or Lighting Load

**Circuit Breaker**

**Fuse**



**Contactor DILM**

# Power circuit wiring

This section refers to the wiring in the feeder and branch circuits. For information on wiring in the control circuit, see page 45.

## Internal wiring (Reference UL 508A Section 29, 66.5):

- All internal wiring conductors shall be copper.
- All conductors in the power circuit should be labeled at the termination point with letters or numbers corresponding with the wiring diagram provided in the industrial control panel.
- Power circuit conductors should not be smaller than 14 AWG.
- For single loads, power circuit conductors for motors or heater loads should be sized for an ampacity not less than 125% of the full-load current.
- For multiple loads, such as multiple motors or a motor with other loads, power circuit conductors shall be sized for an ampacity not less than 125% of all heater loads plus 125% of the largest motor load plus the full-load ampere ratings of all remaining motors and other loads that are simultaneously operable.
- The wire size is selected from the table on page 33 based on the calculated wire ampacity. Conductors used in group motor applications should also comply with Table 66.2 (Reference Section 66.7.5).

## Field wiring (Reference to UL 508A Section 28.3, 66.4):

- Not smaller than 14 AWG.
- For single loads, the field wiring conductors should be sized for an ampacity of 125% of the full-load current.
- For multiple loads, such as multiple motors or a motor with other loads, the field wiring is sized based on the sum of 125% of the largest motor FLA, plus the sum of the other full-load currents of the remaining loads.
- The wire size is selected from the table on page 33 based on the calculated wire ampacity.

## Wire color designation (internal power circuit wiring)



### Black:

All ungrounded power circuit conductors regardless of voltage



### White or gray or three continuous white stripes on other than green, blue, orange or yellow:



Grounded AC current-carrying power circuit conductor regardless of voltage

**Exception:** Insulated conductors sized 4 AWG (21.2 mm<sup>2</sup>) or larger and having insulation colored other than as in Section 17.4 shall be identified at each termination point by a white marking, such as tape wrapped around the conductor.



## Ampacity of insulated conductors according NEC table 310.15(B)

Circuit Size Copper Conductor	Ampacity 60°C	Ampacity 75°C	Ampacity 90°C
AWG 14	15	20	25
AWG 12	20	25	30
AWG 10	30	35	40
AWG 8	40	50	55
AWG 6	55	65	75
AWG 4	70	85	95
AWG 3	85	100	115
AWG 2	95	115	130
AWG 1	110	130	145
AWG 1/0	125	150	170
AWG 2/0	145	175	195
AWG 3/0	165	200	225
AWG 4/0	195	230	260
250 kcmil	215	255	290
300 kcmil	240	285	320
350 kcmil	260	310	350
400 kcmil	280	335	380
500 kcmil	320	380	430
600 kcmil	350	420	475
700 kcmil	385	460	520
750 kcmil	400	475	535
800 kcmil	410	490	555
900 kcmil	435	520	585
1000 kcmil	455	545	615
1250 kcmil	495	590	665
1500 kcmil	525	625	705
1750 kcmil	545	650	735
2000 kcmil	555	665	750

For group motor applications where two or more motors are protected by a single device, wire sizes should comply with the fuse/breaker size in UL 508A Table 66.3 at right.

## Ampacities of insulated conductors – Reference to UL 508A table 28.1

Wire Size AWG	mm <sup>2</sup>	Copper 75°C (167°F)
14	2.1	15
12	3.3	20
10	5.3	30
8	8.4	50
6	13.3	65
4	21.2	85
3	26.7	100
2	33.6	115
1	42.4	130
1/0	53.5	150
2/0	67.4	175
3/0	85.0	200
4/0	107.2	230
250 kcmil	127	255
300	152	285
350	177	310
400	203	335
500	253	380
600	304	420
700	355	460
750	380	475
800	405	490
900	456	520
1000	506	545
1250	633	590
1500	760	625
1750	887	650
2000	1013	665

For multiple conductors of the same size (1/0 AWG or larger) at a terminal, the ampacity is equal to the value in this table for that conductor multiplied by the number of conductors that the terminal is able to accommodate.

## Relationship between conductor size and overcurrent protection rating for power circuits – Reference to UL 508A table 66.3

Conductor Size AWG	mm <sup>2</sup>	Maximum Rating of Non-Time Delay Fuse or Inverse Time Circuit Breaker (Amps)	Time Delay or Dual Element Fuse (Amps)
14	2.1	60	30
12	3.3	80	40
10	5.3	100	50
8	8.4	150	80
6	13.3	200	100
4	21.2	250	125
3	26.7	300	150
2	33.6	350	175
1	42.4	400	200
1/0	53.6	500	250
2/0	67.4	600	300
3/0	85.0	700	350
4/0	107.2	800	400

To determine the wire size for motor loads, add the full-load current ratings found in UL 508A Table 50.1 for all external loads being carried by the conductor. Then use UL 508A Table 28.1 on the following page to determine the wire size for the calculated ampacity.

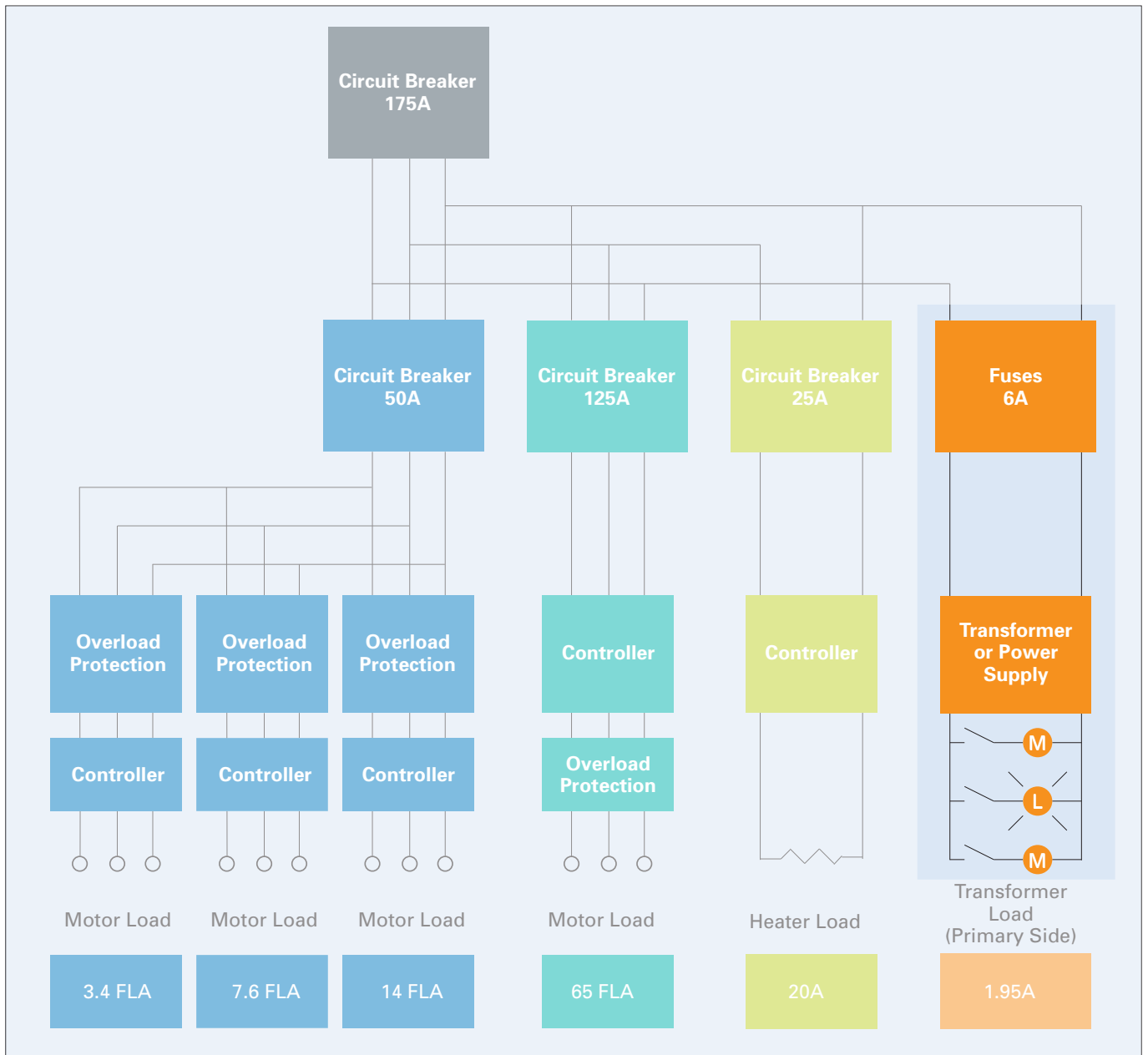
## Full-load motor-running currents in amperes corresponding to various AC horsepower ratings – Reference to UL 508A table 50.1

HP	110–120V		200V		208V		220–240V A <sup>1)</sup>		380–415V		440–480V		550–600V	
	Single-Phase	Single-Phase	Three-Phase	Single-Phase	Three-Phase	Single-Phase	Three-Phase	Single-Phase	Three-Phase	Single-Phase	Three-Phase	Single-Phase	Three-Phase	
1/10	3.0	–	–	–	–	1.5	–	1.0	–	–	–	–	–	
1/8	3.8	–	–	–	–	1.9	–	1.2	–	–	–	–	–	
1/6	4.4	2.5	–	2.4	–	2.2	–	1.4	–	–	–	–	–	
1/4	5.8	3.3	–	3.2	–	2.9	–	1.8	–	–	–	–	–	
1/3	7.2	4.1	–	4.0	–	3.6	–	2.3	–	–	–	–	–	
1/2	9.8	5.6	2.5	5.4	2.4	4.9	2.2	3.2	1.3	2.5	1.1	2.0	0.9	
3/4	13.8	7.9	3.7	7.6	3.5	6.9	3.2	4.5	1.8	3.5	1.6	2.8	1.3	
1	16.0	9.2	4.8	8.8	4.6	8.0	4.2	5.1	2.3	4.0	2.1	3.2	1.7	
1 1/2	20.0	11.5	6.9	11.0	6.6	10.0	6.0	6.4	3.3	5.0	3.0	4.0	2.4	
2	24.0	13.8	7.8	13.2	7.5	12.0	6.8	7.7	4.3	6.0	3.4	4.8	2.7	
3	34.0	19.6	11.0	18.7	10.6	17.0	9.6	10.9	6.1	8.5	4.8	6.8	3.9	
5	56.0	32.2	17.5	30.8	16.7	28.0	15.2	17.9	9.7	14.0	7.6	11.2	6.1	
7 1/2	80.0	46.0	25.3	44.0	24.2	40.0	22.0	27.0	14.0	21.0	11.0	16.0	9.0	
10	100.0	57.5	32.2	55.0	30.8	50.0	28.0	33.0	18.0	26.0	14.0	20.0	11.0	
15	135.0	–	48.3	–	46.2	68.0	42.0	44.0	27.0	34.0	21.0	27.0	17.0	
20	–	–	62.1	–	59.4	88.0	54.0	56.0	34.0	44.0	27.0	35.0	22.0	
25	–	–	78.2	–	74.8	110.0	68.0	70.0	44.0	55.0	34.0	44.0	27.0	
30	–	–	92.0	–	88.0	136.0	80.0	87.0	51.0	68.0	40.0	54.0	32.0	
40	–	–	120.0	–	114.0	176.0	104.0	112.0	66.0	88.0	52.0	70.0	41.0	
50	–	–	150.0	–	143.0	216.0	130.0	139.0	83.0	108.0	65.0	86.0	52.0	
60	–	–	177.0	–	169.0	–	154.0	–	103.0	–	77.0	–	62.0	
75	–	–	221.0	–	211.0	–	192.0	–	128.0	–	96.0	–	77.0	
100	–	–	285.0	–	273.0	–	248.0	–	165.0	–	124.0	–	99.0	
125	–	–	359.0	–	343.0	–	312.0	–	208.0	–	156.0	–	125.0	
150	–	–	414.0	–	396.0	–	360.0	–	240.0	–	180.0	–	144.0	
200	–	–	552.0	–	528.0	–	480.0	–	320.0	–	240.0	–	192.0	
250	–	–	–	–	–	–	604.0	–	403.0	–	302.0	–	242.0	
300	–	–	–	–	–	–	722.0	–	482.0	–	361.0	–	289.0	
350	–	–	–	–	–	–	828.0	–	560.0	–	414.0	–	336.0	
400	–	–	–	–	–	–	954.0	–	636.0	–	477.0	–	382.0	
450	–	–	–	–	–	–	1030.0	–	–	–	515.0	–	412.0	
500	–	–	–	–	–	–	1180.0	–	786.0	–	590.0	–	472.0	

1) To obtain full-load currents for 265 and 277 volt motors, decrease corresponding 220–240 volt ratings by 13 and 17 percent respectively.

# Designing the control circuit

Reference to UL 508A



Control circuits provide the logic for the operation of the components in the power circuit. Control circuits are typically a lower, safer voltage, such as 120 Vac or 24 Vdc. Control power transformers (CPTs) and power supplies are used to transform or convert the power circuit voltage to the control circuit voltage.

Refer to page 39 for selection of the CPT and protective devices.

Refer to page 45 for control circuit wiring.

Eaton also offers a variety of control devices commonly used in control circuits.



## A complete line of circuit protection solutions for UL 508A

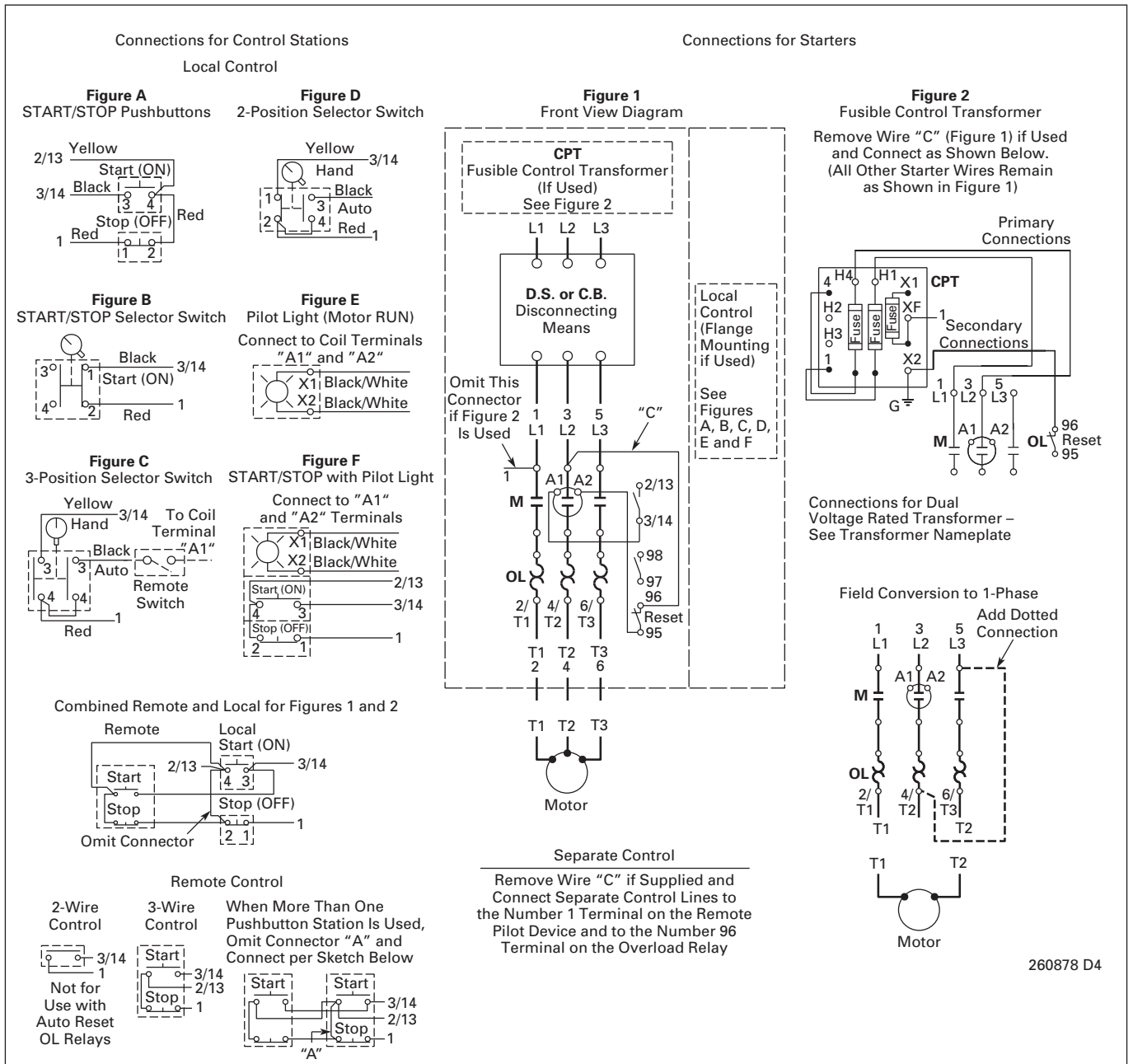


Catalog download:  
[www.eaton.com/bussmannseries](http://www.eaton.com/bussmannseries)

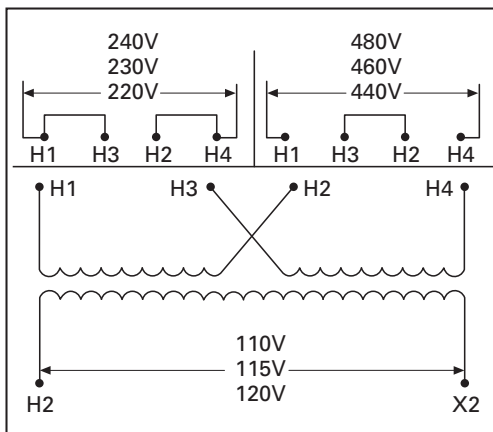
Eaton's Bussmann series UL Listed fuses links, bases and blocks offer unrivalled choice and performance for industrial and commercial applications. Available in a comprehensive range of voltage, current and sizes. They are suitable for applications or equipment to be exported to the USA or the UL markets.

When it comes to protecting and switching, the high quality, safe and reliable products of the xEffect Industrial Circuit Breaker series guarantee protection of people, installations and systems worldwide. The xEffect switchgear range for industrial applications are available with the most important country approbations like VDE (Germany, EAC (Russia), CCC (China) and UL (U.S.)

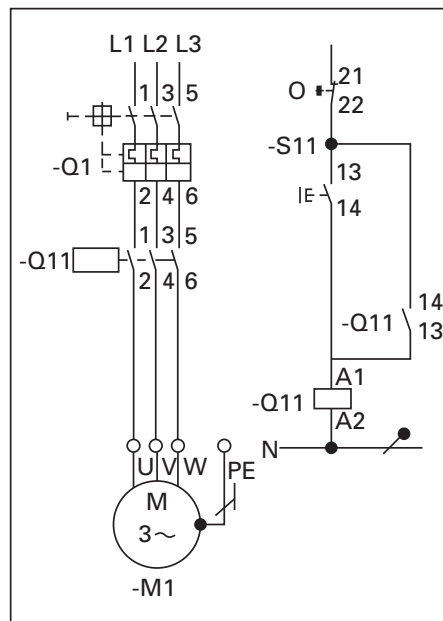
# Common control circuit wiring



260878 D4






240V x 480V Primary, 120V Secondary CPT Wiring Diagram







Manual Motor Controller and Combination Motor Controller Wiring Diagram



## Control transformer

Rated output	Part no.	Short-time rating	primary current	Secondary current	primary protection, max. fuse acc. UL248 or max. circuit breaker acc. UL489	secondary protection, max. fuse acc. UL248 or max. circuit breaker acc. UL489, max. supplementary protector acc. UL1077
kVA	480/120V	kVA	A	A	A	A
						
0.06	STN0,06(480/120)	0.095	0.13	0.50	0.60	-
0.1	STN0,1(480/120)	0.16	0.21	0.83	1.00	-
0.16	STN0,16(480/120)	0.32	0.33	1.33	1.50	-
0.2	STN0,2(480/120)	0.38	0.42	1.67	2.00	-
0.25	STN0,25(480/120)	0.44	0.52	2.08	2.50	3.50
0.315	STN0,315(480/120)	0.6	0.66	2.63	3.00	4.00
0.4	STN0,4(480/120)	0.62	0.83	3.33	4.00	6.00
0.5	STN0,5(480/120)	0.88	1.04	4.17	5.00	6.00
0.63	STN0,63(480/120)	1.51	1.31	5.25	6.00	8.00
0.8	STN0,8(480/120)	2.25	1.67	6.67	8.00	10.00
1	STN1,0(480/120)	3.28	2.08	8.33	5.00	13.00
1.3	STN1,3(480/120)	4.8	2.71	10.83	6.00	13.00
1.6	STN1,6(480/120)	3.98	3.33	13.33	8.00	16.00
2	STN2,0(480/120)	5.75	4.17	16.67	10.00	20.00
2.5	STN2,5(480/120)	7.24	5.21	20.83	13.00	25.00
3	STN3,0(480/120)	8.36	6.25	25.00	15.00	30.00
4	STN4,0(480/120)	12.2	8.33	33.33	20.00	40.00
0.06	STZ0,06(480/120)	0.13	0.13	0.50	0.60	-
0.1	STZ0,1(480/120)	0.24	0.21	0.83	1.00	-
0.16	STZ0,16(480/120)	0.36	0.33	1.33	1.60	-
0.2	STZ0,2(480/120)	0.44	0.42	1.67	2.00	-
0.25	STZ0,25(480/120)	0.6	0.52	2.08	1.30	3.00
0.315	STZ0,315(480/120)	0.75	0.66	2.63	1.60	4.00
0.4	STZ0,4(480/120)	1.1	0.83	3.33	2.00	5.00
0.5	STZ0,5(480/120)	1.6	1.04	4.17	2.50	6.00
0.63	STZ0,63(480/120)	1.7	1.31	5.25	3.00	8.00
0.8	STZ0,8(480/120)	2	1.67	6.67	4.00	10.00
1	STZ1,0(480/120)	2.8	2.08	8.33	5.00	13.00
1.3	STZ1,3(480/120)	3.7	2.71	10.83	6.00	17.50
1.6	STZ1,6(480/120)	5.5	3.33	13.33	8.00	20.00
2	STZ2,0(480/120)	7	4.17	16.67	10.00	20.00
2.5	STZ2,5(480/120)	9	5.21	20.83	13.00	25.00
3	STZ3,0(480/120)	11.5	6.25	25.00	15.00	30.00
4	STZ4,0(480/120)	15	8.33	33.33	20.00	40.00

## UL Low voltage – branch circuit fuse links overview

	Class CC	Class J	Class RK1	Class T
				
Catalog numbers	LP-CC, FNQ-R, KTK-R	LPJ-SP(I), JKS	LPN-RK-SP(I), LPS-RK-SP(I), KTN-R, KTS-R	JJK, JJS
Rated voltage	V AC	600	600	600
	V DC	300	300	160/170
Rated current	Up to 30 A	Up to 600 A	Up to 600 A	Up to 1200 A
Breaking capacity	RMS Sym	200 kA	200/300 kA	200 kA
	DC	20 kA	100 kA	20/100 kA
Operating class	Time delay, fast acting	Time delay, fast acting	Time delay, fast acting	Fast acting
Fuse holders	Optima, CHCC, HPF, HPS	CUBEFuse, CH Class J modular holders, Safety J™	N/A	N/A
Fuse blocks	BCM	Power distribution, modular knifeblade, JM600, JP Pyramid blocks panel mount, modular type, BH modular-style	Modular knifeblade, RM250 and RM600	BH Modular style, T300 and T600 panel mount
Standards	CE, UL Listed and CSA Certified			
Applications	Specialised circuits, industrial control, isolated in-line fuse holder, line protection small control transformers	Power panelboards, branch circuit breaker panelboard mains, machinery disconnects, industrial control	Large distribution switchboards, power panelboards, motor control centers, machinery disconnect switches	Large apartment complexes, multi family meter stacks, VFD line protection

## UL Low voltage – supplementary fuse links overview

	Fast acting	Time delay
		
Catalogue numbers	KTK	KLM
Rated voltage	V AC	600
	V DC	-
Rated current	Up to 30 A	Up to 30 A
Breaking capacity	RMS Sym	100 kA
	DC	N/A
Operating class	Fast acting fuse links	Time delay fuse links
Fuse holders	Optima, CH, HPG, HPC, HPS, HPM, HPF, HEB, HEX, HEY, NDNF1-WH, CCP	Optima, CH, HPG, HPC, HPS, HPM, HPF, HEB, HEX, HEY, NDNF1-WH, CCP
Fuse blocks	BCM, 4421 and 4515	BCM, 4421 and 4515
Standards	CE, UL Listed and CSA Certified	
Applications	Control circuits, lightning circuit protection, meter circuits	Circuit with high inrush currents (motor/transformer loads). Supplemental protection for 125 V AC and 250 V AC inductive circuits



## Branch circuit fuses - Class CC Low peak<sup>TM</sup> time delay, rejection-type fuses

Rated current A	Rated voltage V	Breaking capacity kA	Operating class	Part no.
0.5	600 V a.c. / 300 V d.c.	200 kA RMS Sym. / 20 kA d.c.	Time delay	LP-CC-1-2
0.6				LP-CC-6-10
0.8				LP-CC-8-10
1				LP-CC-1
1.125				LP-CC-1-1-8
1.25				LP-CC-1-1-4
1.4				LP-CC-1-4-10
1.5				LP-CC-1-1-2
1.6				LP-CC-1-6-10
1.8				LP-CC-1-8-10
2				LP-CC-2
2.25				LP-CC-2-1-4
2.5				LP-CC-2-1-2
2.8				LP-CC-2-8-10
3				600 V a.c. / 150 V d.c.
3.2	LP-CC-3-2-10			
3.5	LP-CC-3-5-10			
4	LP-CC-4			
4.5	LP-CC-4-1-2			
5	LP-CC-5			
5.6	LPC-CC-5-6-10			
6	LP-CC-6			
6.25	LP-CC-6-1-4			
7	LP-CC-7			
7.5	LP-CC-7-5-10			
8	LP-CC-8			
9	LP-CC-9			
10	LP-CC-10			
12	LP-CC-12			
15	LP-CC-15			
20	600 V a.c. / 300 V d.c.	LP-CC-20		
25		LP-CC-25		
30		LP-CC-30		



## Branch circuit fuses – Class J Limitron<sup>TM</sup> fast-acting fuses

Rated current A	Rated voltage V	Breaking capacity kA	Operating class	Part no.
1	600 V a.c.	200 kA RMS Sym.	Fast-acting	JKS-1
2				JKS-2
3				JKS-3
4				JKS-4
5				JKS-5
6				JKS-6
8				JKS-8
10				JKS-10
12				JKS-12
15				JKS-15
20				JKS-20
25				JKS-25
30				JKS-30
40				JKS-40
45				JKS-45
50				JKS-50
60				JKS-60
70				JKS-70
80				JKS-80
90				JKS-90
100				JKS-100
110				JKS-110
125				JKS-125
150				JKS-150
175				JKS-175
200				JKS-200
225				JKS-225
250				JKS-250
300				JKS-300
350				JKS-350
400	JKS-400			
450	JKS-450			
500	JKS-500			
600	JKS-600			



## Branch circuit fuses – Class CC Limitron™, rejection-type fuses

Rated current A	Rated voltage V	Breaking capacity kA	Operating class	Part no.
0.25	600 V a.c.	200 kA RMS Sym.	Time-delay	FNQ-R-1-4
0.3				FNQ-R-3-10
0.4				FNQ-R-4-10
0.5				FNQ-R-5-10
0.6				FNQ-R-6-10
0.75				FNQ-R-3-4
0.8				FNQ-R-8-10
1				FNQ-R-1
1.125				FNQ-R-1-1-8
1.25				FNQ-R-1-1-4
1.3				FNQ-R-1-3-10
1.4				FNQ-R-1-4-10
1.5				FNQ-R-1-1-2
1.6				FNQ-R-1-6-10
1.8				FNQ-R-1-8-10
2				FNQ-R-2
2.25				FNQ-R-2-1-4
2.5				FNQ-R-2-1-2
2.8				FNQ-R-2-8-10
3				FNQ-R-3
3.2				FNQ-R-3-2-10
4				FNQ-R-4
4.5				FNQ-R-4-1-2
5				FNQ-R-5-10
5.6	FNQ-R-5-6-10			
6	FNQ-R-6			
6.25	FNQ-R-6-1-4			
7	FNQ-R-7			
7.5	FNQ-R-7-1-2			
8	FNQ-R-8			
9	FNQ-R-9			
10	FNQ-R-10			
12	FNQ-R-12			
15	600 V a.c. / 300 V d.c.	200 kA RMS Sym. / 20 Ka d.c.		FNQ-R-15
17.5				FNQ-R-17-1-2
20				FNQ-R-20
25	600 V a.c.	200 kA RMS Sym.		FNQ-R-25
30				FNQ-R-30



## Branch circuit fuses – Class CC Limitron™, rejection-type fuses

Rated current A	Rated voltage V	Breaking capacity kA	Operating class	Part no.
0.1	600 V a.c.	200 kA RMS Sym.	Fast-acting	KTK-R-1-10
0.125				KTK-R-1-8
0.2				KTK-R-2-10
0.25				KTK-R-1-4
0.3				KTK-R-3-10
0.4				KTK-R-4-10
0.5				KTK-R-5-10
0.6				KTK-R-6-10
0.75				KTK-R-3-4
1				KTK-R-1
1.5				KTK-R-1-1-2
2				KTK-R-2
2.5				KTK-R-2-1-2
3				KTK-R-3
3.5				KTK-R-3-1-2
4				KTK-R-4
5				KTK-R-5
6				KTK-6
7				KTK-7
8				KTK-8
9				KTK-9
10				KTK-10
12				KTK-12
15				KTK-15
20	KTK-20			
25	KTK-25			
30	KTK-30			



## Supplementary fuses – Time-delay fuses

Rated current A	Rated voltage V	Breaking capacity kA	Operating class	Part no.
0.1	500 V a.c.	10 kA	Time-delay	FNQ-1-10
0.125				FNQ-1-8
0.15				FNQ-15-100
0.188				FNQ-3-16
0.2				FNQ-2-10
0.25				FNQ-1-4
0.3				FNQ-3-10
0.4				FNQ-4-10
0.5				FNQ-5-10
0.6				FNQ-6-10
0.8				FNQ-8-10
1				FNQ-1
1.125				FNQ-1-1-8
1.25				FNQ-1-1-4
1.5				FNQ-1-1-2
1.6				FNQ-1-6-10
2				FNQ-2
2.25				FNQ-2-1-4
2.5				FNQ-2-1-2
3				FNQ-3
3.2				FNQ-3-2-10
4				FNQ-4
4.5				FNQ-4-1-2
5				FNQ-5
5.6				FNQ-5-6-10
6				FNQ-6
6.25				FNQ-6-1-4
7				FNQ-7
8				FNQ-8
9				FNQ-9
10	FNQ-10			
12	FNQ-12			
14	FNQ-14			
15	FNQ-15			
20	FNQ-20			
25	FNQ-25			
30	FNQ-30			



## Supplementary fuses – Fast-acting fuses

Rated current A	Rated voltage V	Breaking capacity kA	Operating class	Part no.
0.1	600 V a.c.	100 kA	Fast acting	KTK-1-10
0.125				KTK-1-8
0.2				KTK-2-10
0.25				KTK-1-4
0.3				KTK-3-10
0.4				KTK-4-10
0.5				KTK-1-2
0.6				KTK-6-10
0.75				KTK-3-4
1				KTK-1
1.25				KTK-1-1-4
1.5				KTK-1-1-2
2				KTK-2
2.5				KTK-2-1-2
3				KTK-3
3.5				KTK-3-1-2
4				KTK-4
5				KTK-5
6				KTK-6
7				KTK-7
7.5				KTK-7-1-2
8				KTK-8
9				KTK-9
10				KTK-10
12				KTK-12
15				KTK-15
20				KTK-20
25				KTK-25
30				KTK-30



## Branch circuit fuses – Class J Low peak<sup>TM</sup> dual-element, time delay fuses

Rated current A	Rated voltage V	Breaking capacity kA	Operating class	Part no.
<b>Low peak dual element, time delay fuse links</b>				
1	600 V a.c./ 300 V d.c.	300 Ka RMS Sym. / 100 kA d.c.	Time delay	LPJ-1SP
1.25				LPJ-1-1-4SP
1.6				LPJ-1-6-10SP
1.8				LPJ-1-8-10SP
2				LPJ-2SP
2.25				LPJ-2-1-4SP
2.5				LPJ-2-1-2SP
2.8				LPJ-2-8-10SP
3				LPJ-3SP
3.2				LPJ-3-2-10SP
3.5				LPJ-3-1-2SP
4				LPJ-4SP
4.5				LPJ-4-1-2SP
5				LPJ-5SP
5.6				LPJ-5-6-10SP
6				LPJ-6SP
7				LPJ-7SP
8				LPJ-8SP
9				LPJ-9SP
10				LPJ-10SP
12				LPJ-12SP
15				LPJ-15SP
17.5				LPJ-17-1-2SP
20				LPJ-20SP
25				LPJ-25SP
30				LPJ-30SP
35				LPJ-35SP
40				LPJ-40SP
45				LPJ-45SP
50				LPJ-50SP
60				LPJ-60SP
70				LPJ-70SP
80				LPJ-80SP
90				LPJ-90SP
100				LPJ-100SP
110	LPJ-110SP			
125	LPJ-125SP			
150	LPJ-150SP			
175	LPJ-175SP			
200	LPJ-200SP			
225	LPJ-225SP			
250	LPJ-250SP			
300	LPJ-300SP			
350	LPJ-350SP			
400	LPJ-400SP			
450	LPJ-450SP			
500	LPJ-500SP			
600	LPJ-600SP			



# Wire selection for control circuits

## Wire color designation (internal power circuit wiring)



### Black:

All ungrounded control circuit conductors operating at the supply voltage



### Red:

Ungrounded AC control circuits operating at a voltage less than the supply voltage



**Blue:** Ungrounded DC control circuits



### Yellow or orange:

Ungrounded control circuits or other wiring, such as for cabinet lighting, that remain energized when the main disconnect is in the OFF position



### White or gray or three white stripes on other than green, blue, orange, or yellow:

Grounded AC current-carrying control circuit conductor regardless of voltage



### White with blue stripe:

Grounded DC current-carrying control circuit conductor



### White with yellow stripe or white with orange stripe:

Grounded AC control circuit current-carrying conductor that remains energized when main disconnect switch is in the OFF position



Wire size for control circuits must be no smaller than 18 AWG, with exception of control circuits for PLC input/outputs. Wire size is determined from Table 38.1 based on the amp rating of the overcurrent protective device for the control circuit or the amp rating of the secondary of the CPT or power supply.

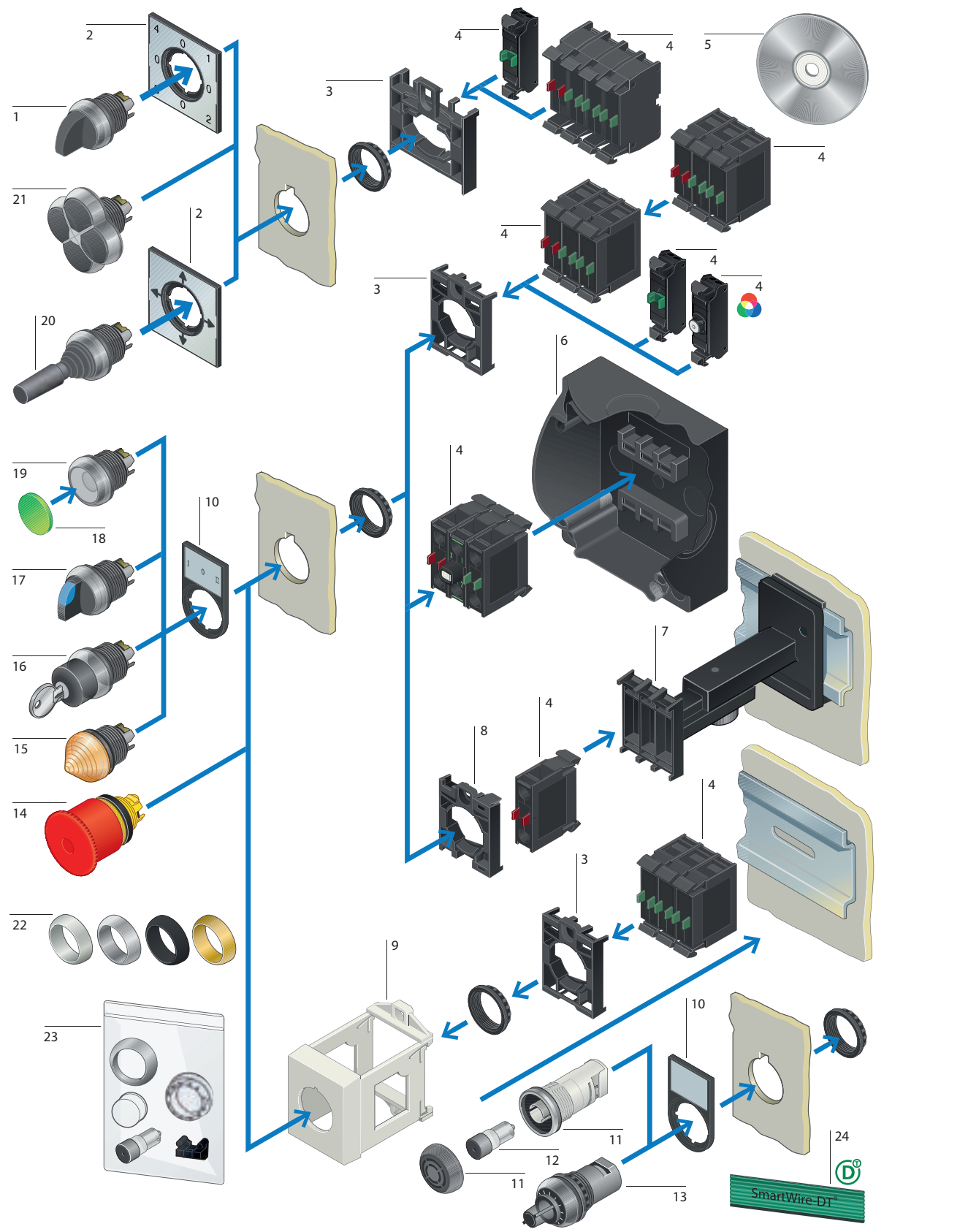
## Ampacity of control circuit conductors – Reference to UL 508A table 38.1

Ampacity, Amperes	Conductor Size	
	AWG	mm <sup>2</sup>
10	16	1.3
7	18	0.82
5	20 <sup>2)</sup>	0.52
3	22 <sup>2)</sup>	0.32
2	24 <sup>2)</sup>	0.20
1	26 <sup>2)</sup>	0.13
0.8	28 <sup>1)2)</sup>	0.08
0.5	30 <sup>1)2)</sup>	0.05

1) Where these conductors are contained in a jacketed multi-conductor cable assembly.

2) These sizes of conductors are only for connection of control circuits for electronics programmable input/output and static control (having no moving parts).

# Logic control – pilot devices selection



- |                                   |                            |   |                              |
|-----------------------------------|----------------------------|---|------------------------------|
| 1 4-way selector switch actuators | 8 Centring adapter         | 14 Controlled stop pushbuttons/<br>emergency-stop buttons | 20 Joystick                  |
| 2 Labels with label mounts        | 9 IVS top-hat rail adapter | 15 Indicator light  | 21 4-way pushbutton          |
| 3 Mounting clamp                  | 10 Label mounts            | 16 Key-operated actuators                                 | 22 Bezels                    |
| 4 Contact/LED elements            | 11 Acoustic device         | 17 Changeover switches                                    | 23 Accessories               |
| 5 Individual inscription          | 12 Buzzer                  | 18 Button plates/lenses                                   | 24 SmartWire-DT ribbon cable |
| 6 Surface mounting enclosure      | 13 Potentiometer           | 19 Pushbutton actuators                                   |                              |
| 7 Telescopic clip                 |                            |   |                              |



## In great shape: The world market control circuit devices RMQ Titan



Catalog download:  
[www.eaton.eu/catalog](http://www.eaton.eu/catalog)

The RMQ-Titan devices have been granted numerous national approvals and ship classifications, meaning they are ready for use anywhere in the world. Especially the RMQ-Titan units with a flush design and a frame size of 30mm meets the requirements of the US market. The flush pushbuttons features a modular design and are the perfect match for the RMQTitan series, flush contacts, and LED elements.

Modern styling has been combined with an optimum range of functions. The perfect outfit for use at machines and on panels around the world. The ergonomically shaped button elements are matched to the shape of a fingertip for even more comfortable operations.

### Rules for Operator Controls

1. Start buttons and switches should be located either above or to the left of the associated stop button.



2. Every control panel that includes operator controls should include an emergency stop. This emergency stop should be a mushroom or palm type that is self-latching.



# Build it in.



## SmartWire-DT: The communication and wiring system for more profitability



Catalog download:  
[www.eaton.eu/catalog](http://www.eaton.eu/catalog)

Customer expectations today are focused on increased performance in a more compact design, shorter delivery times, and the right price. To meet these requirements, machines need to be built in shorter time frames, using smaller control cabinets with intelligent, energy-saving devices that allow a smaller footprint compared with existing components. For plants and systems the availability is the key to higher profitability. SmartWire-DT is a unique wiring solution that streamlines connection and communications inside and outside control panels. Machine and system builders globally are finding that SmartWire-DT can be integrated easily into machines in a smaller control cabinet, reducing the time and effort for wiring their machines and systems by up to 85 %. In operation the profitability of the machines and system can be raised. Digital and analog data help to improve the performance and to avoid downtimes.





## Cleaner wiring solution

### Background

US-based Renegade Parts Washers manufactures heavy-duty parts washing machines for numerous applications. Founded in 1996, the company has grown from offering a single solution to now having the capability to manufacture customized solutions built to their customers' specifications.

### Challenge

Customers depend on a solution that will quickly and efficiently clean a high volume of parts and demand the shortest lead time between production and final end-user installation. With the increasing complexity of its machines, Renegade was looking for ways to optimize its production processes.

### Solution

A machine control system based on the SmartWire-DT communication system cut wiring time, improved flexibility, and supported the implementation of advanced diagnostic features. This meant simpler machines at a lower cost and with added functionality. Extension up to 600m outside the control panel also allowed the connection of sensors and other machine-mounted devices.

### Results

"SmartWire-DT has transformed our control systems," says Dave Barney, owner of Renegade Parts Washers. "It has allowed us to cut our wiring times while improving the flexibility of our systems and adding advanced diagnostic facilities that are a big selling point when we talk to our customers. We'll certainly be using SmartWire-DT on all of the automated machines we build in the future."



## Streamlining processes for reliable production

### Background

Grossi Electric Inc. is a full service electrical company, based in Escalon (CA), that specializes in industrial and commercial construction and automation services. Mike Grossi, founder and principal, was interested in expanding its services into lean agricultural automation systems. The opportunity arose when a nearby walnut processing plant contacted Grossi Electric to help facilitate some of its processes.

### Challenge

On the motor control side, the walnut plant project seemed fairly straightforward, though Grossi saw there was great potential to develop a more elegant solution. The vision was to make the harvesting process smarter, simpler and more effective.

### Solution

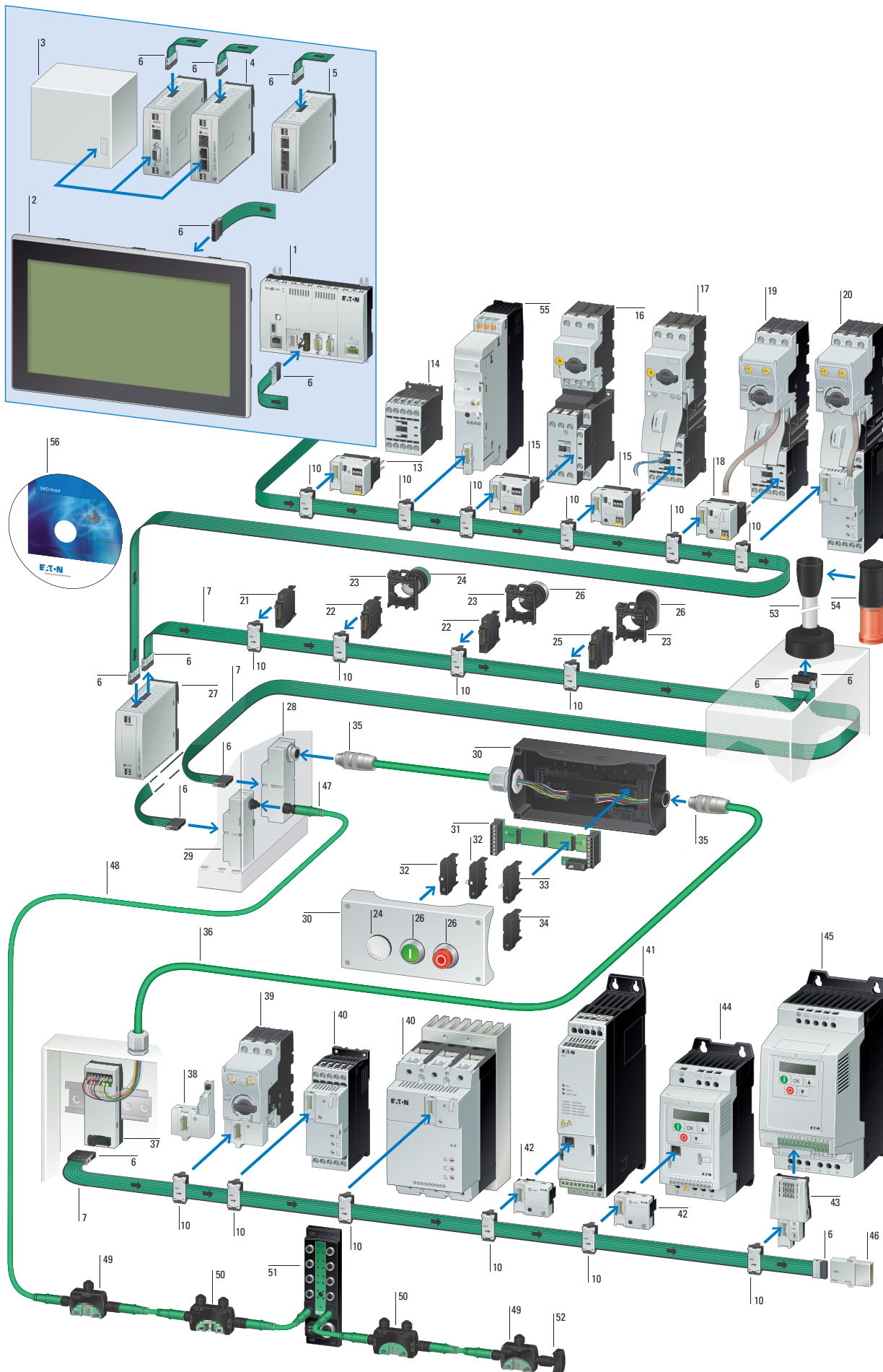
By combining Eaton products into a total package solution, Grossi designed a very affordable and cost-effective control system for the walnut processing plant. SmartWire-DT enabled the control panels to be built and wired more quickly, with greater reliability. The result was a completely intelligent communication and control system for the panel, while keeping to a very simple design.

### Results

In collaboration with Eaton, Grossi Electric designed and implemented a smarter and leaner automation control system for the walnut hulling and dehydration machine. The overall look and feel of the control panel was clean and simple to the end user, while the customer loved the small footprint, which was a quarter of the original design. Grossi noted benefits of the Eaton system solution in terms of improved reliability, ease of maintenance and comprehensive cost savings for his company and his customer.

# SmartWire-DT

## System overview



1 Compact PLC	17 MSC motor starters	31 SWD card for function elements, base fixing	45 DA1 variable frequency drives
2 Touch panel	18 SWD PKE module (motor starter)	32 SWD LED elements for base fixing	46 SWD bus termination resistor for 8 pole flat band conductor
3 PLC with field bus interface	19 Motor starters with PKE electronic motor protection	33 SWD function elements for base fixing	47 M12 plug connector, 5 pole
4 Gateways	20 DS7 soft starters with PKE electronic motor protection	34 SWD universal modules, base fixing	48 Round cable, 5-pole
5 Control relays	21 SWD universal module, front mount	35 SWD plug-in connector, 8 pole	49 SWD I/O module IP67, 2 I/O
6 SWD blade terminal, 8 pole	22 SWD LED element, front mount	36 SWD round cable, 8 pole	50 SWD I/O module IP67, 4 I/O
7 SWD ribbon cable, 8 pole	23 RMQ-Titan mounting clamps for flush mounting plates	37 SWD adapter for flat/round cable for top-hat rail mounting	51 SWD I/O module IP67, max. 16 I/O
8 SWD I/O module	24 RMQ-Titan indicator lights	38 SWD PKE module (motor-protective circuit-breaker)	52 SWD bus termination resistor IP67 for 5 pole round cable, M12
9 SWD module for circuitbreakers and residual current circuit-breakers	25 SWD function elements for front mount	39 PKE motor-protective circuit-breakers	53 Base module signal tower SL4/SL7
10 SWD external device plug, 8 pole	26 SWD operating elements	40 Soft Starter DS7	54 Signal towers SL4 /SL7
11 SWD interface for NZM	27 SWD power feeder module	41 DE1 Variable speed starter	55 Electronic Motor Starter EMS
12 NZM circuitbreakers	28 SWD control panel bushing ribbon cable to 8 pole round cable, M20	42 SWD function element for DC1 variable frequency drive, DE1 variable speed starter	56 SmartWire-DT planning and ordering aid (SWD-Assist)
13 SWD contactor module	29 SWD control panel bushing ribbon cable to 5 pole round cable, M12	43 SWD function element for DA1 variable frequency drive	
14 DILM contactor	30 Surface mounting enclosure RMQ-Titan	44 DC1 variable frequency drives	
15 SWD contactor module with manual 0 automatic switch			
16 Motor-protective circuitbreakers			

## Features

### SmartWire-DT coordinators

#### Touch panel

With SWD master switch and PLC function  
3.5", 5.7", 7" or 10" TFT-LCD screen, additional field bus interfaces, Ethernet, WEB server

#### Compact controller

With SWD master switch  
Additional fieldbus interfaces, Ethernet, WEB server

#### Control relay

With SWD master switch

#### Gateways

Connection of SmartWire-DT to fieldbus (e.g. CANopen, Profibus, Profinet ...)

Supply voltage for the SmartWire-DT modules

Feeder unit for the control voltage for the motor starter or contactor

Support of up to 99 SmartWire-DT modules

### SmartWire-DT module

I/O modules to connect digital and analog input/output signals in IP20, IP67 degree of protection

DS7 Soft starter with integrated connection

Function element to connect to:

- Pilot devices RMQ-Titan
- SL4/7 signal tower
- Contactor DILM
- Motor-protective circuitbreaker PKZ/PKE
- PKE32, 65 circuitbreaker
- NZM2, 3, 4 circuitbreakers
- Miniature circuit breaker (MCB)
- DE1 Variable speed starter
- DC1, DA1 variable frequency drives

### SmartWire-DT-Assist (SWD-Assist)

Easily create SmartWire-DT networks integrated validity check

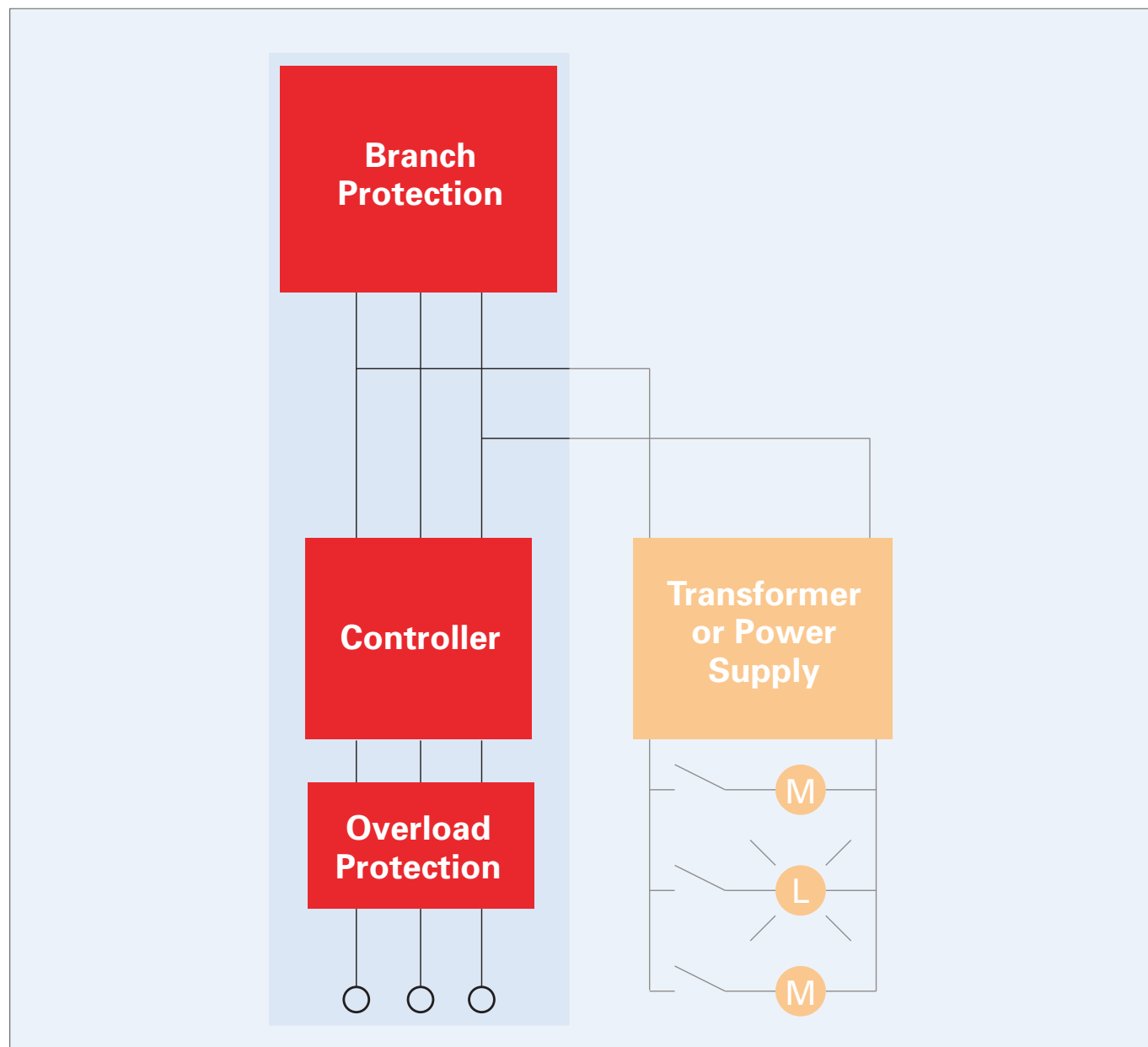
Generate order lists.

Online functions:

- Configuration check and comparison
- Display of all input/output data, setting outputs
- Display of parameters and diagnostics

Free download at [www.eaton.eu/swd](http://www.eaton.eu/swd)

# Sizing the branch protection for a single motor and a control circuit



**Single Motor Load and Control Circuit with Shared Branch Protection**

For single motor load control panel where the branch protective device acts as the main for the panel and the control circuit is tapped off the load side of the device, the branch protective device is sized by the following:

1. Multiply the motor FLA (from Table 50.1 on page 35) with the following percentage based on the type of protective device from the table at right:
2. Add the full-load current on the primary of the CPT from the table below.
3. Select the closest standard protective device rating.

See page 8 for selection of the controller and overload protection.

Conductors of a control circuit that are tapped from the load side of a branch circuit device (and where the power voltage is the same as the control voltage – no CPT) shall be protected by overcurrent devices rated not more than as specified in the table at the right.

## Common formulas and conversions

	Direct Current	Single-Phase (AC)	Three-Phase (AC)
Current (I) from HP	$I = \frac{HP \times 746}{V \times \%EFF}$	$I = \frac{HP \times 746}{V \times \%EFF \times PF}$	$I = \frac{HP \times 746}{V \times \%EFF \times PF \times 1.73}$
Current (I) from kW	$I = \frac{kW \times 1000}{V}$	$I = \frac{kW \times 1000}{V \times PF}$	$I = \frac{kW \times 1000}{V \times PF \times 1.73}$
Current (I) from kVA		$I = \frac{kVA \times 1000}{V}$	$I = \frac{kVA \times 1000}{V \times 1.73}$
Horsepower (HP)	$HP = \frac{V \times I \times \%EFF}{746}$	$HP = \frac{V \times I \times \%EFF \times PF}{746}$	$HP = \frac{V \times I \times \%EFF \times PF \times 1.73}{746}$

Voltage Drop Calculations	
<b>V</b>	Voltage drop
<b>I</b>	Current
<b>L</b>	Length of cable/wire (ft)
<b>D</b>	Conductor cross section (circular mil)
<b>K</b>	Resistivity of conductor <ul style="list-style-type: none"> <li>• K = 12 for circuits loaded more than 50% of rating (copper)</li> <li>• K = 11 for circuits loaded less than 50% of rating (copper)</li> </ul>
Two-wire, single-phase	$V = \frac{2K \times L \times I}{D}$
Three-wire, three-phase	$V = \frac{2K \times L \times I \times 0.866}{D}$

Conversions	
1 inch	2.54 cm
3.28 feet	1 meter
1 yard	0.91 meters
1 mile	5,280 feet
1 mile	1.609 kilometers
144 square inches	1 square foot
9 square feet	1 square yard
640 acres	1 square mile
1 cubic foot	7.48 gallons

## Circuit protective device – Reference to table UL 508a table 66.5

Conductor Size		Control Circuit Overcurrent Device (Amps)	Branch Circuit Overcurrent Device (Amps)
AWG	mm <sup>2</sup>		Control in Wire Panel
Larger than 14	Larger than 2.1	Equal to wire capacity	Remote Control
14	2.1	20	400% of wire ampacity
16	1.3	20	300% of wire ampacity
18	0.82	20	80
			40
			25
			20

See table on page 6 for breaker and fused disconnect part numbers, and page 40 for fuses.

## Branch Circuit Protection

Type	Percent of FLA
Non-time delay fuse and Class CC fuse	Up to 300%
Dual element fuse (time delay) except Class CC	Up to 175%
Inverse-time circuit breaker	Up to 250%
Self-protected combination motor controller	100%
Manual self-protected combination motor controller	100%

# North American environmental type ratings for electrical equipment

## Comparison of North American and IEC/EN environmental ratings for electrical equipment

IP ratings per IEC/EN standards cannot be used as a substitute for North American Type ratings. **The IP ratings shown represent a rough comparison only.** A precise conversion is not possible since tests and evaluation criteria in the relevant standards differ greatly from one another. UL/CSA and NEMA type ratings are often used interchangeably. The significant difference between the two is that a UL/CSA type rating represents third party certification by an approved testing agency, which is the preferred manner in which ratings are verified in North America.

North American environmental type ratings are referenced in the following standards:

- NFPA 70 (National Electrical Code),
- CEC (Canadian Electrical Code),
- UL 50E, UL 508A,
- CSA-C22.2 No. 94-M91 (2006),
- NEMA 250-2008  
(National Electrical Manufacturers Association).

North American environmental Type ratings	Application	Rough equivalency to IP ratings per IEC/EN 60529, DIN 40050
<b>UL/CSA Type 1</b> Incidental contact with enclosed equipment; falling dirt	Indoor use	IP20
<b>UL/CSA Type 2</b> Driptight	Indoor use	IP22
<b>UL/CSA Type 3</b> Dusttight, raintight, degree of protection against rain, snow and sleet	Outdoor use	IP55
<b>UL/CSA Type 3 R</b> Rainproof, degree of protection against rain, snow and sleet	Outdoor use	IP24
<b>UL/CSA Type 3 S</b> Dust-tight, rain-tight, protection against sleet and ice	Outdoor use	IP55
<b>UL/CSA Type 3 X, 3 RX, 3 SX</b> same as 3, 3 R and 3 S, but with corrosion resistance	Outdoor use	IP55
<b>UL/CSA Type 4</b> Watertight, raintight, dusttight	Indoor or Outdoor use <sup>1)</sup>	IP66
<b>UL/CSA Type 4 X</b> Watertight, raintight, dusttight, corrosion resistant	Indoor or Outdoor use <sup>1)</sup>	IP66
<b>UL/CSA Type 5</b> Driptight, dusttight	Indoor use	IP53
<b>UL/CSA Type 6</b> Raintight, watertight, temporarily submersible	Indoor or Outdoor use <sup>1)</sup>	IP67
<b>UL/CSA Type 12</b> Common industrial rating, driptight, dusttight	Indoor use	IP54
<b>UL/CSA Type 13</b> driptight, dusttight, oiltight	Indoor use	IP54

1) Take note of manufacturer instructions!



## A complex job made simple – Successful export to North America

Machinery from Germany, Europe, and the rest of the world that follows IEC standards is frequently exported to North America (the United States and Canada). However, the codes and standards that need to be complied with there are significantly different from those used in other parts of the globe.

One thing that is certain is that the percentage of technologically sophisticated and innovative German machines that are being exported is growing considerably. This is why it is important for you to be absolutely ready for the UL market and the specifics it entails. After all, providing electrical and electronic equipment that meets all of your North American customers' expectations is a perfect way to stand out among the competition.

The EMEA Eaton Experience Center offers custom-tailored training courses focusing on UL 508A and NFPA 79-compliant panel building. These courses are a great way to learn exactly what it takes to successfully export electrical equipment to North America.

[www.eaton.eu/training](http://www.eaton.eu/training)

### During the training course, you will learn:

- The basics behind the relevant codes and standards
- Device types and main applications in North America
- Mains / power supply
- Short Circuit Current Rating
- .... and much more!



At Eaton, we're energized by the challenge of powering a world that demands more. With over 100 years experience in electrical power management, we have the expertise to see beyond today. From groundbreaking products to turnkey design and engineering services, critical industries around the globe count on Eaton.

We power businesses with reliable, efficient and safe electrical power management solutions. Combined with our personal service, support and bold thinking, we are answering tomorrow's needs today. Follow the charge with Eaton. **Visit [eaton.eu](http://eaton.eu).**

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