

Grouping of Motors on a Single Branch Circuit

Not all Motor Starters are branch circuit overcurrent protection, but are being used as such. There are Code limitations with Motor Starters when we group motors on a single branch overcurrent device and these limitations are not well known.

Background:

There are two types of Motor Starters certified for use in Canada... **Motor Starters** and **Type E Combination Motor Controllers**. Motor Starters do not offer any branch circuit protection. Type E Combination Motor Controllers offer branch circuit protection for motors.

The following definitions are from a CSA T.I.L K-17:

Manual Motor Controller (Motor Starter):

A device designed for manual-only control of a motor under normal and locked rotor conditions. A motor controller may incorporate a means to automatically interrupt motor overload currents. Some manual motor controllers are provided with limited short circuit interrupting capabilities; however, the certification report will state that the ability of these devices to open the short circuit currents was not evaluated. A manual motor controller is evaluated to CAN/CSA-C22.2 No. 14.

Type E Combination Motor Controller:

A single device designed to control a motor under normal and locked rotor conditions, disconnect the motor branch circuit and interrupt short circuit and overload overcurrents having non-replaceable or integral discriminating overload and short circuit sensors, and provided with one or more sets of contacts where the contacts cannot be isolated for separate testing. A Type E combination motor controller is evaluated to the requirements of CSA Standard C22.2 No. 14-95.

They have similar names, which has resulted in misapplication of motor starters as branch circuit protection.

The misapplications started slowly with the introduction of IEC Starters many years ago. Although IEC starters are accepted in Europe as overcurrent devices, they could not meet North American standards as an over-current device as per C22.2 No. 5.1. So they have been certified similar to NEMA starters as required in C22.2 No. 14.

Although the literature is clear in saying they must meet NEC and CEC there is no clear Canadian literature to explain the Code rules. Combining that with the fact they are accepted in Europe as an overcurrent device, it slowly became common to see the popular IEC motor starters applied as "Branch Over-current Devices" in many applications.

To add to the confusion, some devices are certified as motor starters some are certified as Type E combination motor controllers. Neither is defined in the Code book.

What are the specific issues?

1. Maintaining consistent code application.
2. Motor starters not having adequate over-current protection in front of the motor starter resulting in severe welding of contacts and failure.

3. Oversized overcurrent for motors and conductors when group fusing.

Solution:

The following is an explanation on how to apply *Ontario Electrical Safety Code* rules when using motor starters so that a number of motors can be grouped under a single branch circuit over-current device and to show how it is different for Type E combination motor controllers.

Use of Manual Motor Starters when grouping motors on a single branch over-current device

The term "Motor Starter" is not a defined term in the code. In the Code Rule 28-206 (b) (i), the words "the control equipment" mean "Motor Starter". This rule permits the use of a single branch circuit over-current device for a group of motors, and related "control equipment" (Motor Starters), subject to a few limitations that we will discuss.

This rule will allow grouping of a number of motors under one branch circuit over-current device provided:

- ⌚ Rule 28-206 (b)(i) Motor Starters are used (and marked with the maximum group fuse rating).
- ⌚ Rule 28-206 A single overcurrent is selected based on the motor feeder rule (Rule 28-204 (1)).
- ⌚ Rule 28-106 (3) Tap Conductors to motors are 1/3 the feeder ampacity.

In summary this is saying the following:

Select one branch circuit over-current device to protect a number of motors and related control equipment, so the control equipment (Motor Starters) can withstand a fault, until the branch circuit over-current device operates.

The Code rules are difficult to read. The rules are shown with the key parts highlighted.

- ⌚ Rule 28-206 Grouping of Motors on a Single Branch Circuit.

Two or more motors shall be permitted to be grouped under the protection of a single set of branch circuit over-current devices having a rating or setting calculated in accordance with Rule 28-204(1) provided that the protection conforms to one of the following:

- (b) Protection is provided for the control equipment of the motors by having the branch circuit overcurrent devices rated or set at:
 - (i) Values not in excess of those marked on the control equipment for the lowest rated motor of the group, as suitable for the protection of that control equipment; or

- ⌚ Rule 28-106 (3) Conductors, Individual Motors

"Tap conductors supplying individual motors from a single set of branch circuit overcurrent devices supplying two or more motors shall have an ampacity at least equal to that of the branch circuit conductors, except where the tap conductors do not exceed 7.5 m in length, they shall be permitted to be sized in accordance with Subrule (1) or (2) provided the ampacity so determined is not less than 1/3 of the ampacity of the branch circuit conductors".

In summary, these rules permit grouping of a number of motors under one branch circuit overcurrent device if:

- ⌚ Rule 28-206 (b)(i) Motor Starters are used (and marked with the maximum group fuse rating).
- ⌚ Rule 28-206 A single overcurrent is selected based on the feeder rule. (Rule 28-204 (1))

- ⌚ Rule 28-106 (3) Tap Conductors to motors are 1/3 the feeder ampacity.

Use of a Type E Combination Motor Controller

How does a Type E Combination Motor Controller get referenced in the Code?

The type of equipment referred to in Rule 28-200 (c) and 28-210 , is a Type E Combination Motor Controller. These rules are difficult to read. The rules are shown with the key parts highlighted:

- ⌚ 28-200 Branch Circuit Overcurrent Protection.

"Each ungrounded conductor of a motor branch circuit shall be protected by an overcurrent device complying with the following:

(c) Instantaneous trip (magnetic only) circuit interrupters shall be permitted where applied in accordance with Rule 28-210; and

- ⌚ 28-210 Instantaneous-Trip Circuit Breakers (see Appendix B).

Instantaneous-trip circuit breakers, when used for branch circuit protection, shall be:

(a) Part of a combination motor starter or controller that also provides overload protection; and

These two rules give us overcurrent protection of the conductor and the motor if we use a Type E Combination Motor Controller.

Method for Grouping Motors when using Motor Starters (not Type E)

Step One: One should know the Manual Starters/Protectors are not certified as overcurrent devices in North America (see CSA Technical Information Letter TIL K-17). Starters can be certified for branch circuit overcurrent protection for motors only. These are certified as Type E Combination Motor Controllers.

If it is just a "Motor Starter", then it has no overcurrent application by itself as per the Ontario Electrical Safety Code.

Step Two: We can use these Motor Starters in North America based on Rule 28-206 (b) (i). Some manufacturers have tested their devices and have marked ratings up to 2000 amperes for the maximum fuse size for group fusing. This is the maximum size of overcurrent allowed for group fusing.

However this does not mean that this is the allowable *Code* setting of the upstream branch circuit overcurrent as shown in Step Three.

Step Three: Rule 28-206 refers us back to 28-204 (1) for the setting of the overcurrent device. This rule generally forces us to use a much smaller overcurrent setting than the maximum marked on the device. Go to Table 29 to pick an overcurrent device and then add the other loads that are in operation at the same time and that is the setting of the single branch overcurrent device. Now we have the overcurrent device for the motor, but we still need the overcurrent for the motor conductors.

Step Four: When looking for the overcurrent protection for the conductors supplying the individual motors. Rule 28-106 (3) gives us guidance. The ampacity of the tap conductors to individual motors cannot be less than 1/3 the ampacity of the branch circuit conductors *and* cannot exceed 7.5 metres.

Example to show grouping of seven motors on a single branch circuit:

Data:

- One 10hp motor, full load amps 14, supplied with #12 wire.
- Six 2 hp motors, full load amps 3.4, supplied with #14 wire.

Motor Starters are each marked 1200 amperes maximum group fusing

Method:

Select single overcurrent fuse per Rule 28-206 Table 29 time delay fuse at 45 amperes. (1.75 times 14 amp for the 10 hp, plus 3.4 amperes load per motor times 6 motors = 45 amperes.) A number 14 conductor is OK for the 2 hp motors (Motor Tap Rule). A Number 12 is OK for the 10 hp motor (Motor Tap Rule). Maximum conductor length from the overcurrent protection ahead of the motor starter to the motor is limited to 7.5 metres.

In summary, the seven motors are protected with one fuse rated at 45 amperes.

Note: The wire size for the motor starters may not exceed the maximum terminal size of the motor starter. For example for a starter with a maximum terminal size of #10 awg, when we use the motor tap Rule 28-106(3), the maximum overcurrent protection size is really limited to 90 amperes (3 times 30 i.e. not 1200 amperes). The feeder rule may still reduce this size as well.

Rick Martin P. Eng. MaSc.
Senior Research Engineer
ESA Field Evaluation
1-800-559-5356