Devices for Motor Circuits

Thermal Magnetic (Inverse Time) Circuit Breakers
As Listed to UL 489

These circuit breakers are intended to provide branch, feeder, and main protection, with interrupting ratings from 5,000 to 200,000 amps. Properly sized inverse time circuit breakers are intended to provide motor branch circuit short-circuit and ground fault protection. They may be used for group motor protection only when the circuit breaker is tested, listed and marked (430.53(C)) for group installation (see 430.53(A) & (B) for exceptions). There are no circuit breakers listed for group motor protection except for HVAC applications, in which case they are marked HACR. They are suitable for use as a motor disconnecting means per NEC® 430.109, as a motor controller (On-Off Function) per NEC® Article 430, Part VII, and as both a motor disconnecting means and motor controller per NEC® 430.111.

Allowed Uses:
• Motor Branch Short-circuit and Ground Fault Protection
• Motor Overload Protection
• Group Motor Protection as the short-circuit and ground fault protective device only when the circuit breaker is tested, listed and marked for group installation. (See 430.53(A) & (B) for exceptions)
• Motor Branch Circuit Disconnecting Means
• Motor Controller

Identification
Circuit Breakers listed to UL489 will contain a marking near the agency symbol. This marking should read circuit breaker or an abbreviation such as Cir. Bkr.

Instantaneous Trip Circuit Breakers (MCPs)
As recognized To UL 489

These are circuit breakers without overload (thermal) protection capability. They are intended to provide only branch circuit, short-circuit and ground protection for individual motor branch circuits. They may not be used to provide main, motor feeder, motor overload, general branch circuit or group motor protection. Because they are recognized, not listed, they cannot be used with loose control. NEC® 430.52 requires that they shall only be used as part of a listed combination controller. MCPs are short-circuit tested only in combination with a motor controller and overload device. They are not labeled with an interrupting rating by themselves. Per NEC® 430.109 exception 7, they may be used as a motor disconnecting means when part of a listed combination motor controller.

Allowed Uses:
• Motor Branch Short-circuit and Ground Fault Protection only when listed for use in combination with a specific motor controller/overload device
• Motor Branch Circuit Disconnecting Means
• Motor Controller

Identification
Instantaneous Trip Circuit Breakers recognized to UL489 will contain a recognized or component acceptance marking. This marking indicates that the product can not be used “stand alone” and is limited to certain conditions of use.

Manual Motor Controllers (Manual Motor Protectors)
As listed to UL 508

These manual motor starters, sometimes called MMPs, often combine a magnetic short-circuit trip and adjustable motor overload protection. They are intended to provide motor overload protection per NEC® 430.32.

Creepage and clearance distances are typically not as great as required in UL 489, and therefore they cannot be listed as a circuit breaker. MMPs cannot provide branch motor circuit short-circuit and ground fault protection. They need a branch circuit overcurrent device and a motor disconnecting means on the line side for both single motor and group motor applications. Some IEC manual motor protectors have been tested and listed for group motor applications [as the protected (downstream) device, not the protecting (upstream) device] so that several of them may be able to be protected by one larger upstream fuse sized not to exceed the maximum size allowed per the device listing. Devices listed for use in group motor installations will be marked for such use to indicate that the device has undergone the appropriate testing to deem it suitable for such use. Some of these devices are rated with slash voltage limitations (such as 480Y/277V). This limits their use to solidly grounded wye type systems only. Manual motor controllers may be used as a motor controller (On-Off Function) to meet NEC® Article 430 Part VII. Unless otherwise marked, MMPs do not meet requirements for a motor disconnecting means as required in NEC® 430.109. If it is marked “Suitable as Motor Disconnect” it shall be permitted to serve as a motor disconnecting means if it is located between the final motor branch-circuit, short-circuit and ground fault protective device and the motor. This marking and listing is optional, so a review of the device markings will be required if it is intended to be used for this purpose.

Allowed Uses:
• Motor Overload Protection
• Group motor applications as the protected (downstream) device only when the device is tested, listed and marked and the upstream fuse (protecting device) is sized within the maximum allowed per the device’s listing.
• Motor Controller
• “At the Motor” Disconnect if marked “Suitable as motor Disconnect” and located between the motor branch circuit short-circuit and ground fault protective device and the motor.
Warning
Supplemental Protectors are NOT suitable for Motor Branch Circuit Protection

Supplemental protectors are being used for motor branch circuit protection in numerous applications throughout the industry. This is a MISAPPLICATION and the urgency of the matter is prompting the creation of safety notices, articles, and technical bulletins to alert the users of this misapplication. Supplemental protectors are not suitable for branch circuit protection and cannot be used for this purpose per 240.10 of the National Electrical Code®. Supplemental protectors are intended to be used as a component of an end product such as commercial appliances, kitchen appliances, luminaires (lighting fixtures), etc. They are offered in a wide variety of performance characteristics, voltage ratings, and interrupting ratings and therefore each supplemental protector is only allowed to be used under specific conditions. Supplemental protectors are UL recognized to UL1077, Supplemental protectors for use in Electrical Equipment, for this reason. A recognized or restricted product is not field installable and therefore an investigation assuring application of the product within its conditions of acceptability is required.

Why Are They Being Misapplied?
Here are some of the popular reasons why:
• Supplemental protectors look very similar to Molded Case Circuit Breakers leading to the assumption that they provide the same protection
• Supplemental protectors are often labeled as circuit breakers or Miniature Circuit Breakers (MCB) in literature
• Many of these devices are rated as a circuit breaker per IEC and confusion over North American and IEC ratings leads to misapplication

So What Do I Need To Do?
In order to correct the application, suitable protection for the motor branch circuit needs to be provided. The simplest correction to this problem is the replacement of the misapplied supplemental protector with a device that is suitable for branch circuit protection.

• A WORD OF CAUTION: The supplemental protector can only be used in an end product that is evaluated as an assembly. If the equipment does not go through an investigation, there is no assurance that the supplemental protector is being used for its intended use within its conditions of acceptability. Therefore the replacement of this device is the safest approach.

So What Can I Use?
NEC® 430.52 provides a list of acceptable devices for motor branch circuit protection. Among the list of acceptable devices are time delay and fast acting branch circuit fuses.

Summary
Supplemental protectors are being misapplied on numerous occasions. Many reasons lead to this misapplication including mistaking supplemental protectors as North American circuit breakers. The key to properly identifying supplemental protectors is to look for the recognition mark. If the device you are using has a recognition mark, more than likely it is a supplemental protector and replacement is necessary for a proper installation.

For more in-depth discussion, download Tech Talk 3 and Supplement from www.cooperbussmann.com

Motor Circuit Protection Device Selection Chart & Supplemental Protectors

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<tr>
<td>Motor Circuit and Controller Disconnect</td>
<td>Yes¹</td>
<td>Yes</td>
<td>No</td>
<td>Yes⁶,⁷</td>
<td>No</td>
<td>No</td>
<td>Yes⁵,⁶</td>
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<td>No</td>
<td>No</td>
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<tr>
<td>Motor Controller</td>
<td>Yes²</td>
<td>Yes</td>
<td>Yes⁹</td>
<td>Yes⁹</td>
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<td>Yes⁹</td>
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<td>Motor Overload</td>
<td>Yes</td>
<td>Yes³</td>
<td>Yes¹⁰</td>
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<tr>
<td>Motor Disconnect</td>
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<td>Yes</td>
<td>Yes⁴</td>
<td>Yes</td>
<td>No</td>
<td>Yes⁴</td>
<td>No</td>
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1. When used in conjunction with a UL98 Fusible Switch.
2. Where used in conjunction with a UL98 or UL508 fusible switch. If UL508 switch, see footnote 4
3. Often cannot be sized close enough.
4. Must be located on the load side of motor branch short-circuit protective device, marked “Suitable as Motor Disconnect,” and be provided with a lockable handle.
5. When used in conjunction with a motor starter as part of a listed and labeled combination motor controller.
7. Additional Terminal Kit Often Required.
8. If Slug Voltage Rated, Limited to Solidly Grounded Wye Systems ONLY.
10. Class 10 Overload Protection Only.
Motor Circuits – Choice of Overcurrent Protection

Motor circuits have unique characteristics and several functions, such as short circuit protection, overload protection and automatic/remote start/stop, that may be required. Sometimes the comment is made that users prefer circuit breakers because they can be reset. Let’s examine the choice of either circuit breakers or circuit-limiting fuses for motor branch circuit protection.

In the case to be examined, fuses and circuit breakers (includes magnetic only circuit breakers which are called MCPs or motor circuit protectors) are sized with the intent to provide only short circuit and ground fault protection for the motor branch circuit protection per 430.52. Other means, such as overloads, relays, provide the motor overload protection. Typical thermal magnetic circuit breakers can only be sized for motor branch circuit protection (typically 200% - 250% of motor current) because if they are sized closer, the motor starting current trips the circuit breaker’s instantaneous mechanism. Magnetic only circuit breakers (MCPs) are intentionally not provided with overload capability; they only operate on short-circuit currents. There are some fuses such as the FR-5-R, FRN-R, LPN-RK and PS-RK fuses that can be sized close enough for motor running overload protection or backup motor running protection. But for the discussion in this section, assume current-limiting fuses are sized only for motor short circuit and ground fault protection.

It is important to note that in this protection level being discussed, a circuit breaker or fuses should only open if there is a fault on the motor circuit. A separate overload protective device, such as an overload relays, provides motor overload protection per 430.32. Here are some important considerations:

1. OSHA regulation 1910.334(b)(2) Use of Equipment states:

   **Reclosing circuits after protective device operation.** After a circuit is deenergized by a circuit protective device, the circuit may not be manually reenergized until it has been determined that the equipment and circuit can be safely energized. The repetitive manual reclosing of circuit breakers or reenergizing circuits through replaced fuses is prohibited. NOTE: When it can be determined from the design of the circuit and the overcurrent devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, no examination of the circuit or connected equipment is needed before the circuit is reenergized.

   So the speed of reclosing a circuit breaker after a fault is not an advantage. The law requires that if the condition is a fault (that is the only reason the circuit breaker or fuses should open on a motor circuit), then the fault must be corrected prior to replacing fuses or resetting the circuit breaker.

2. The typical level of short circuit protection for the motor starter provided by circuit breakers and MCPs is referred to as Type 1. This is because most circuit breakers are not current-limiting. So, for a loadside fault, the starter may sustain significant damage such as severe welding of contacts and rupturing of the heater elements. Or the heater/overload relay system may lose calibration. This is an acceptable level of performance per UL508, which is the product standard for motor starters. Current-limiting fuses can be selected that can provide Type 2 “no damage” short circuit protection for motor starters.

   Consequently, with circuit breaker protection, after a fault condition, significant downtime and cost may be incurred in repairing or replacing the starter. With properly selected fuses for Type 2 protection, after the fault is repaired, only new fuses need to be inserted in the circuit; the starter does not have to be repaired or replaced.

3. Circuit breakers must be periodically tested to verify they mechanical operate and electrically tested to verify they still are properly calibrated within specification. The circuit breaker manufacturers recommend this. Typically circuit breakers should be mechanically operated at least every year and electrically tested every 1 to 5 years, depending on the service conditions. Modern current-limiting fuses do not have to be maintained or electrically tested to verify they still will operate as intended. The terminations of both circuit breakers and fusible devices need to be periodically checked and maintained to prevent thermal damage. Plus fuse clips should be periodically inspected and if necessary maintained.

4. After a circuit breaker interrupts a fault, it may not be suitable for further service. UL489, the product standard for molded case circuit breakers, only requires a circuit breaker to interrupt two short-circuit currents at its interrupting rating. Circuit breakers that are rated 100 amps or less do not have to operate after only one short circuit operation under “bus bar” short circuit conditions. If the fault current is high, circuit breaker manufacturers recommend that a circuit breaker should receive a thorough inspection with replacement, if necessary. How does one know a circuit breaker’s service history or what level of fault current that a circuit breaker interrupts? With modern current-limiting fuses, if the fuse interrupts a fault, new factory calibrated fuses are installed in the circuit. The original level of superior short circuit protection can be there for the life of the motor circuit.

5. After a fault, the electrician has to walk back to the storeroom to get new fuses; that is if spare fuses are not stored adjacent to the equipment. This does require some additional down time. However, if fuses opened under fault conditions, there is a fault condition that must be remedied. The electrician probably will be going back to the storeroom anyway for parts to repair the fault. If properly selected current-limiting fuses are used in the original circuit, the starter will not sustain any significant damage or loss of overload calibration.

With circuit breaker protection on motor circuits, after a fault condition, it may be necessary to repair or replace the starter, so a trip to the storeroom may be necessary. And if the starter is not significantly damaged, it may still need to be tested to insure the let-through energy by the circuit breaker has not caused the loss of starter overload calibration. Also, the circuit breaker needs to be evaluated for suitability before placing it back into service. Who is qualified for that evaluation? How much time will that take?

In summary, resettability is not an important feature for motor branch circuit (short circuit) protection and resettability of the branch circuit protective device is not a benefit for motor circuits. As a matter of fact, resettability of the motor branch circuit overcurrent protective device may encourage an unsafe practice. The function of motor branch circuit protection is fault protection: short circuit and ground fault protection. Faults do not occur on a regular basis. But when a fault does occur, it is important to have the very best protection. The best motor branch circuit protection can be judged by (1) reliability - its ability to retain its calibration and speed of operation over its lifetime, (2) current-limiting protection -its ability to provide Type 2 “no damage” protection to the motor starter, and (3) safety - its ability to meet a facility’s safety needs. Modern current-limiting fuses are superior to circuit breakers for motor branch circuit protection.

After a heavy fault on a motor branch circuit, you may need to (1) replace the fuses or (2) reset the circuit breaker and replace the starter (and maybe the circuit breaker, too).
Five Choices — 1 Solution

IEC Motor Starter Protection

Five methods of providing motor starter overcurrent protection are delineated in the five examples that follow. In noting the levels of protection provided by each method, it becomes apparent that the use of dual-element, time-delay fuses (Example 5) is the only one that gives protection at all levels whether it be “Type 2,” “Back-up Overload,” “Back-up Single-Phase,” etc.

These examples are based on a typical motor circuit consisting of an IEC Starter, and a 10 HP, 460V motor (Service factor = 1.15). These “Level of Protection” examples reflect the branch circuit protective device operating in combination with the IEC starter overload relays sized at approximately 115% of motor FLA and contactor Ie = 18 amps.