



Instantaneous-Trip Circuit Breakers

Introduction

Instantaneous-trip circuit breakers, also known as magnetic-only circuit breakers, look like thermal-magnetic circuit breakers, and that may be partly why people sometimes assume that they can be used anywhere thermal-magnetic circuit breakers can be used. Customers occasionally specify them for use in “combination contactor” units (“contactor only” units, consisting of a circuit breaker and a contactor) when there is overload protection at or near the motor, or, more frequently, they may specify them for a branch circuit breaker supplying a motor when there is a starter (contactor and overload relay) downstream near the motor. These applications are not permitted by the National Electrical Code (NEC). Why not? What are instantaneous-trip circuit breakers, what purpose do they serve, and under what conditions is it permissible to use them? This article provides some answers to these questions.

Overcurrent Protection

NEC[®] Paragraph 210.20 requires that branch circuits be protected by overcurrent protective devices. For protection of motor circuits, NEC 210.20 and Table 240.3 point to Article 430.

Overcurrents may be categorized as high level (short circuits) or low level (overloads). In non-motor circuits, a single device (circuit breaker or fuse) usually provides both short-circuit protection and overload protection; in motor circuits (except for very small motors), the overload protection is typically provided by an overload relay, while the branch circuit short-circuit protection is provided by a fuse, circuit breaker, a self-protected control device, or a manual self-protected combination controller.

Circuit breakers come in two types, thermal-magnetic circuit breakers, also called inverse-time circuit breakers, and instantaneous-trip circuit breakers, also known as magnetic-only circuit breakers, or motor-circuit protectors.

Thermal-magnetic circuit breakers include both a magnetic tripping function, for short-circuit protection, and a thermal tripping function, for overload protection. As the alternate name “inverse-time” implies, the higher the overload, the shorter the time in which the circuit breaker will open.

Thermal-magnetic circuit breakers are sometimes used for motor-circuit protection. Since for motor circuits the overload protection is usually provided by an overload relay, the circuit breaker does not have to be small enough to provide overload protection. However, NEC 430.52 limits the maximum rating of the circuit breaker (250% of motor full load current in most cases, unless that is not high enough to permit the motor to start, in which case the limit is 400% of full-load current). Given this limit, it is sometimes difficult or impossible to properly size the circuit breaker because the high inrush current of the motor may cause nuisance tripping of the circuit breaker.

Instantaneous-Trip Circuit Breakers

For this reason, instantaneous-trip circuit breakers were developed. These circuit breakers have the same magnetic trip function as thermal-magnetic circuit breakers, but lack the thermal trip function. (The magnetic trip function operates more or less instantaneously, hence the name.) So, for example, a 100 A thermal-magnetic circuit breaker will trip within a short time if it is subjected to a current of 400 A, but a 100 A instantaneous-trip circuit breaker will carry that overload indefinitely, if the adjustable trip is set above that level.

Per NEC 430.52, the maximum allowable trip setting of an instantaneous trip circuit breaker is 800 percent of motor FLC for most motors, unless that is insufficient for starting the motor, in which case it may be increased to as much as 1300 percent of motor FLC (those numbers are 1100 percent and 1700 percent for Design B energy-efficient motors). This has the benefit of allowing the circuit breaker to be sized to handle the motor inrush. However, the circuit breaker's lack of a thermal trip function means that another device is needed for overload protection of the motor circuit (motor, motor-control apparatus, and motor branch-circuit conductors). To ensure that an instantaneous-trip circuit breaker will not be used without overload protection, NEC 430.52(C)(3) states that:

“An instantaneous trip circuit breaker shall be used only if adjustable and if part of a listed combination motor controller having coordinated motor overload and short-circuit and ground-fault protection in each conductor ...”.

That is, an instantaneous-trip circuit breaker is to be used only as a part of a complete Listed package; it is not a stand-alone device. This is reiterated in the standard that covers circuit breakers, UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures, which says, in Paragraph 1.1, that it covers “...instantaneous-trip circuit breakers (circuit interrupters) specifically intended for use as part of a combination motor controller in accordance with the National Installation Codes ...”.

Since instantaneous-trip circuit breakers are “restricted in performance capabilities,” they are certified as UL Recognized components, rather than UL Listed components (thermal-magnetic circuit breakers are UL Listed). One illustration of the importance of this difference is that under the requirements of UL 508A, Industrial Control Panels, a panelbuilder may select Listed components to form a combination motor controller and install it in a Listed panel without testing if the disconnect/short-circuit protective device is a thermal-magnetic circuit breaker. However, a combination motor controller that uses an instantaneous-trip circuit breaker may be used only if it has been evaluated to the requirements of UL 508 (which include a battery of tests), and if it is described in the panelbuilder's UL file.

Under the requirements of UL 489, inverse-time circuit breakers must be marked with an interrupting rating, but instantaneous-trip circuit breakers are not permitted to carry this marking. However, when they are evaluated in a combination motor controller, the entire package is given a short-circuit current rating.

Combination Motor Controllers

A combination motor controller is, per UL 508, Industrial Control Equipment, “A controller intended for motor service that provides a disconnecting means, branch circuit (short-circuit and ground fault) protection, motor controller, and motor overload protection.”

The requirements for UL Listing of combination motor controllers have historically been contained in UL 508. They have recently been added to UL 845, Motor Control Centers, as well. Combination motor controllers must undergo a series of tests including short circuit (standard fault and high fault), temperature rise, current withstand, calibration, and others.

Combination motor controllers may be sold as stand-alone assemblies or they may be installed in assembled equipment such as motor control centers, industrial control panels, or switchboards.

Summary

Instantaneous-trip circuit breakers are circuit breakers that have a magnetic trip function but not a thermal trip function. They are designed for one very specific purpose, that being to provide branch-circuit short-circuit protection for motor circuits. The NEC permits their use only in listed combination motor controllers.

For More Information

For more information, refer to UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures; UL 508, Industrial Control Equipment; NEC 430.52(C); UL 845, Motor Control Centers.

All above references to the NEC are to the 2005 Edition.

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