

## SECONDARY CIRCUIT BREAKER SELECTION FOR CONTROL PANEL APPLICATIONS

### Introduction

Selecting the right circuit breakers is very important for ensuring code compliance and electrical safety. The following should be considered to aide in selecting the appropriate circuit breaker for an application:

- UL Listing
- Current Rating
- Current Interrupting Rating
- Breaker Type and Trip Curve
- Accessories

In this brief overview of circuit breaker selection, we will discuss the important specifications of circuit breakers, review the various options that exist, and discuss the pros and cons of these options.

### UL Listing

An important consideration to take into account when selecting circuit breakers is the UL rating of the circuit breaker. To meet UL 508A standard, the circuit breakers installed in the panel must be UL rated. There are two basic types of UL rated circuit breakers, and the designer must select the appropriate breaker for the application:

#### **UL 1077 Supplementary Circuit Breaker**

Supplementary protectors are not intended as a substitute for branch-circuit overcurrent devices. As the name implies, their purpose is supplementary, or additional, protection to the branch-circuit overcurrent device. Supplementary protectors are intended for installation within an appliance or other electrical equipment. As such, this precludes using these devices as branch circuit overcurrent protective devices in distribution equipment, such as a panelboard or switchboard.

A UL 1077 breaker is different from a UL 489 breaker in that it does not require a manual means of circuit disconnect, and the testing requirements for UL listing are much low. Therefore, it should only be used as supplementary protection in conjunction with a UL 489 breaker. For most applications in Industrial Control Panels, UL 1077 breakers should be avoided. UL 1077 breakers are less expensive than UL 489 breakers, so if cost is a concern, UL 1077 breakers can be used for the limited applications they are approved for.

#### **UL 489 Circuit Breaker**

The UL 489 standard covers molded-case circuit breakers, circuit breaker and ground-fault circuit-interrupters, fused circuit breakers, high-fault protectors, and high-fault modules. These circuit breakers are specifically intended to provide service entrance, feeder, and branch circuit protection. This standard also covers instantaneous-trip circuit breakers (circuit interrupters) specifically intended for use as part of a combination motor controller.

The panel builder should ensure that all selected circuit breakers are UL 489 rated, except for the limited cases where a UL 1077 breaker is used in conjunction with a UL 489 breaker that meets the UL requirements.

## **Current Rating**

Circuit breakers must be sized according to the National Electrical Code (NEC). The code generally requires that the circuit breakers are rated to trip at a current lower than the rating of the conductors and equipment on the load side of the breaker. The sizing of the conductors will depend on the type of load, and whether the load is continuous or non-continuous. There are many exceptions and special cases to consider, which include a number of tap rules and exceptions, a provision allowing the use of the next available size breaker, and rules for calculating main breakers with multiple loads. There are many NEC code rules to follow when sizing a breaker, and a panel designer should refer to the NEC for all rules when sizing circuit breakers.

## **Current Interrupting Rating**

Interrupting rating is the maximum short-circuit current an overcurrent protective device can safely interrupt under standard test conditions. This rating is important in the role it plays in an assembly (or control panel's) Short-Circuit Current Rating (SCCR). The SCCR of a panel typically cannot be greater than the lowest interrupting rating of any fuse or circuit breaker, or the lowest short-circuit current rating of all other components in the enclosure. The SCCR rating that is required is determined by the available short-circuit current. A panel cannot be installed in a location where its SCCR rating does not exceed the available short-circuit current. A panel designer must select a breaker with the appropriate current interrupt rating, along with all panel components, to ensure the SCCR of the panel is sufficient for the application.

## **Breaker Type and Trip Curve**

A panel designer must determine the type of breaker (thermal-magnetic or magnetic only), and ensure the trip curve is appropriate for the load being protected.

### **Thermal Magnetic**

Thermal magnetic breakers are the most commonly used, general purpose circuit breakers. These breakers use both a thermal trip unit and a magnetic trip unit in conjunction to protect against both short-circuit and overcurrent events. The thermal trip unit is designed to trip relatively slowly at currents just above the trip rating of the breaker. This helps prevent damage from overcurrent events. The magnetic trip unit is designed to trip very quickly, but only at multiples (generally about 7-11 times) of the trip rating of the breaker. The magnetic trip is important for quick disconnection of the circuit during a short-circuit event. The time vs. current trip curve of a circuit breaker will show the combined tripping characteristics of both the thermal and magnetic trip unit. It is important to select a trip curve to match the characteristics of the protected load, accounting for inrush current. Selecting an appropriate trip curve is also important for electrical coordination, which essentially matches trip curves of all breakers in a distribution system, to prevent breakers upstream from tripping before breakers closer to the load they are protecting. Thermal magnetic breakers should generally be used in all conditions, except where a dedicated overload unit is used.

### **Magnetic Trip Only**

Magnetic only trip circuit breakers only use a magnetic tripping element, and only protects against a short circuit event. By itself, a magnetic trip breaker does not protect against overcurrent conditions. A magnetic trip breaker should only be used where a dedicated overload module is used to protect the same load such as a motor starter with an overload module.

## **Accessories**

### **Shunt Trip**

Adding a shunt trip, which is an option for some circuit breakers, allows the circuit breaker to be tripped electronically. This allows remote tripping of the breaker, or allows certain safety or process conditions to trigger the tripping of the breaker.

### **Position Contacts**

Many circuit breakers will allow an option for adding circuit breaker position contacts. These can either give fully opened/tripped, or closed position of the breaker, and can be used as feedback to a control system or indicators.

## **Conclusion**

Selecting the right circuit breakers requires careful consideration of the application, understanding of applicable codes and standards, and a thorough review of all tradeoffs associated with each option.

The above outline was compiled to highlight important options to consider, but it is only a primer that scratches the surface of circuit breaker selection. It is important to research product options, know the applicable standards, and take the specific application into account when selecting circuit breakers.

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