

## Standard and 100% Rated Circuit Breakers

Retain for future use.

### Introduction

Knowing when to recommend 100%-rated circuit breakers can mean total project savings, added flexibility for future expansions or modifications, and effective circuit protection.

### Standard and 100% Rated Circuit Breakers

The National Electric Code (NEC®) and Underwriters Laboratories® (UL®) standard UL 489 define circuit breaker ratings and control design and testing requirements.

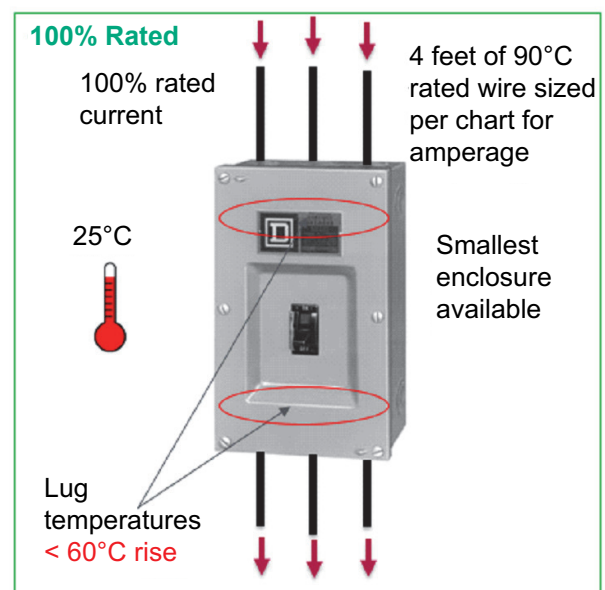
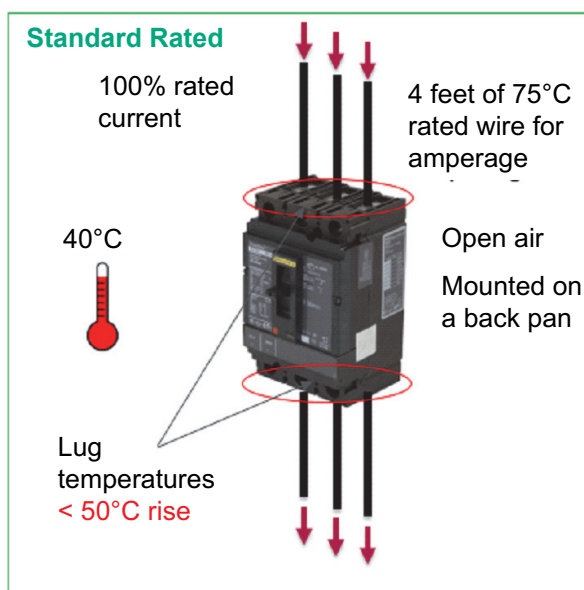
- The National Electrical Code (NEC) defines standard ratings and 100% ratings for circuit breakers.



- UL 489 has design and testing requirements for standard rated and 100% rated circuit breakers to align with the NEC.

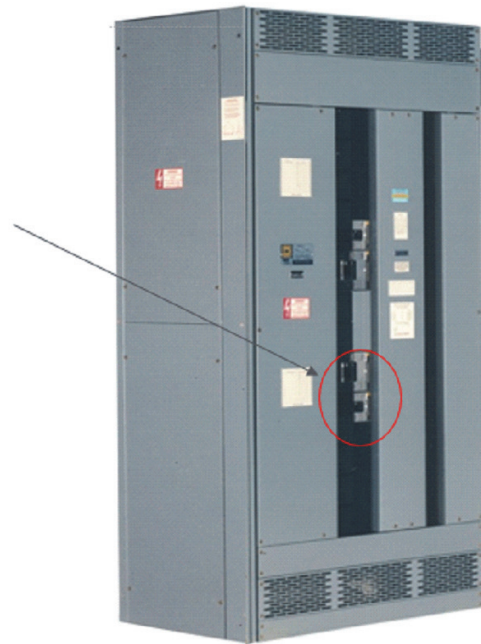


### Testing Requirements for Standard and 100% Rated Circuit Breakers



## Equipment Testing

- Standard rated circuit breakers can be used with normal derating without additional equipment testing
- 100% rated circuit breakers can be used if the equipment is tested and UL Listed for 100% ratings



## General Information

Knowing when to recommend 100% rated circuit breakers can mean total project savings, added flexibility for future expansions or modifications, and effective circuit protection.

As you can see from the description above, to use circuit breakers at 100% of their rating, you must have circuit breakers UL Listed and tested for 100% and the equipment must also be UL Listed and tested for use of the circuit breakers at 100%.

## NEC Section 210

As explained in Section 210-20(a) of the 2014 National Electrical Code (NEC):  
 “Where a branch circuit supplies continuous loads or any combination of continuous and non-continuous loads, the rating of the overcurrent device shall not be less than the non-continuous load plus 125 percent of the continuous load.”

“Exception: Where the assembly, including the overcurrent devices protecting the branch circuit(s), is listed for operation at 100 percent of its rating, the ampere rating of the overcurrent device shall be permitted to be not less than the sum of the continuous load plus the non-continuous load.”

Another restriction applying to 100% rated circuit breakers is found in an exception to Section 210-20(a) of the NEC, especially the words: “Where the assembly, including the overcurrent devices protecting the feeder(s), is listed for operation at 100 percent ...”:

- The minimum enclosure size and ventilation requirements set forth on the circuit breaker are met, or
- The switchboard has been specifically UL tested for 100% operation of the circuit breaker

## NEC Article 215

Additionally, NEC Section 215.2(a) states: “Where a feeder supplies continuous loads or any combination of continuous and non-continuous loads, the minimum feeder conductor size shall have an allowable ampacity not less than the non-continuous load plus 125 percent of the continuous load.”

“Exception No. 1: If the assembly, including the overcurrent devices protecting the feeder(s), is listed for operation at 100 percent of its rating, the allowable ampacity of the feeder conductors shall be permitted to be not less than the sum of the continuous load plus the non-continuous load.”

In short, these article says that a standard-rated circuit (circuit breaker and wire) can carry 80% of the circuit breaker and conductor current rating. In contrast, 100% rated circuits can carry 100% of the circuit breaker and conductor current rating.

## UL 489 Molded Case Circuit Breaker Standard

### Standard Rated Circuit Breakers

Circuit breakers must carry 100% rated current in open air at 40 degrees C until maximum temperatures are reached. The circuit breaker cannot trip and the temperature at the customer connection cannot exceed 50 degrees C rise above ambient.

### 100% Rated Circuit Breakers

Circuit breakers are installed in the smallest enclosure they could be used in. Circuit breaker must carry 100% rated current until maximum temperatures are reached. The circuit breaker cannot trip and the temperature rise at the customer connection cannot exceed 60 degrees C above ambient. If the temperature rise is between 50 and 60 degrees C, the breaker must be labeled with the stipulation that the breaker be cabled using 90 degrees C wire sized at the 75 degrees C chart according to the NEC 310-16.

Paragraph 9.1.4.4 of UL Standard 489: “A circuit breaker, having a frame size of 250 A or greater, or a multi-pole type of any ampere rating rated over 250 V; and intended for continuous operation at 100 percent of rating, shall be marked: ‘Suitable for continuous operation at 100 percent of rating only if used in a circuit breaker enclosure Type (Cat. No.) \_\_\_\_ or in a cubicle space \_\_\_\_ by \_\_\_\_ by \_\_\_\_ mm (inches).’ Equivalent wording shall be permitted. The blanks are to be filled in with the minimum dimensions.”

## Load Calculations

Examine loads to determine if they are primarily continuous loads (three or more hours) or non-continuous loads. If all loads are non-continuous, then both standard and 100% rated circuit breakers can be sized at 100% of the load and the standard rated circuit breaker would be the most economical option. However, if some or all of the loads are continuous, a 100% rated circuit breaker may be the best option.

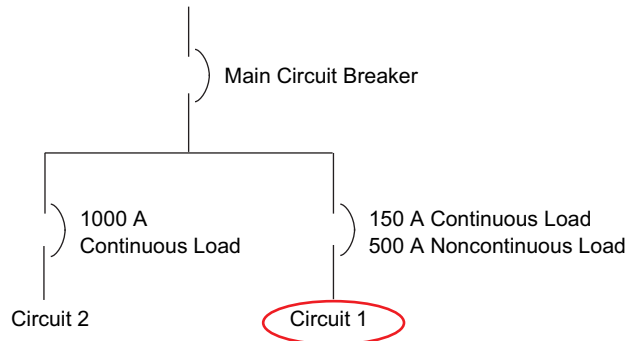
Where possible, segment each distribution circuit into all continuous loads or all intermittent loads. By doing this, the choice of a 100% rated or a standard rated circuit breaker will become clear-cut for each circuit.

Determine the total load on each branch circuit and calculate the ampere rating required for the circuit breaker and conductor using both a standard rated circuit breaker and a 100% rated circuit breaker. Compare the cost of the circuit breaker and conductor for the 100% rated circuit breaker to that of the standard rated circuit breaker. The less expensive option is probably the wiser choice, although capability to handle load growth is an additional consideration.

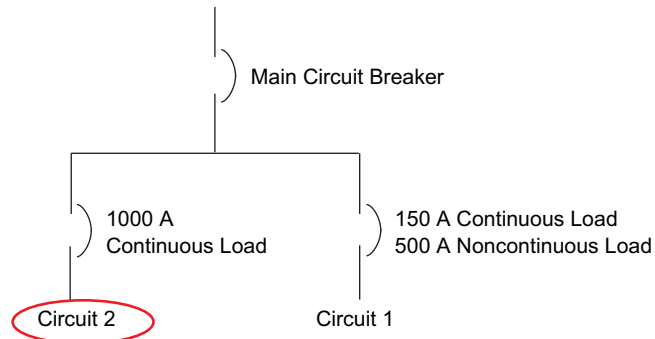
## Circuit Example

### Circuit 1

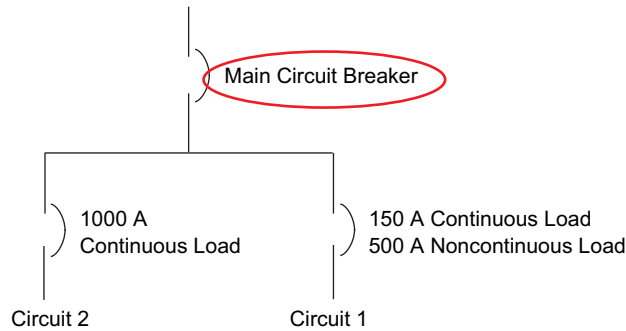
Figure 1 – Main Feed with Two Branch Circuits



1. Using a standard rated circuit breaker:
  - Minimum required ampacity =  $(150 \times 1.25) + 500 = 687$  amperes
  - Because 687 amperes is not an available rating, 700 ampere conductors and a PowerPact™ M-frame circuit breaker would be required.
2. Using a 100% rated PowerPact P-frame circuit breaker
  - Minimum require ampacity =  $150 + 500 = 650$  amperes
  - Because 650 amperes is not a standard rating, an 800-ampere circuit breaker would be required. Even by turning the long-time trip setting down to 720 A the installation would still need the same wiring as the PowerPact M-frame circuit breaker.
  - In this case, the 100% rated PowerPact P-frame circuit breaker does not offer savings to the customer. A standard-rated PowePact M-frame circuit breaker is the most economical choice.

**Circuit 2****Figure 2 – Main Feed with Two Branch Circuits**

1. Using a standard rated circuit breaker:
  - Minimum required ampacity =  $(1000 \times 1.25) = 1250$  amperes
  - Because 1250 amperes is not an available rating, a 1600 ampere circuit breaker would be required (PowerPact R-frame).
2. Using a 100% rated circuit breaker:
  - Minimum required ampacity = 1000 amperes
  - A 1000 ampere circuit breaker would be required (PowerPact P-frame).
  - In this case, the 100% rated circuit breaker offers smaller frame size, which may reduce the size of the end user equipment and the space needed in the electrical room; and smaller conductors.
  - **Although**, if load growth is expected, the standard rated (1600 amperes) circuit breaker does have the capacity for 1120 amperes, or 280 amperes of load growth.

**Circuit Example (Main Circuit Breaker)****Figure 3 – Main Feed with Two Branch Circuits**

1. Using a standard rated circuit breaker:
  - Minimum required ampacity =  $(1000 \times 1.25) + (150 \times 1.25) + 500 = 1937$  amperes
  - The next standard rating for conductors and circuit breakers is 2000 amperes.
2. Using 100% rated circuit breaker:
  - Minimum required ampacity =  $1000 + 150 + 500 = 1650$  amperes
  - The next available size for circuit breakers and conductors is 2000 amperes.
  - In this case, the 100%-rated circuit breaker does not offer savings to the customer. A standard-rated circuit breaker is the most economical choice.