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UL Circuit Breaker Standards Comparison – UL 489 vs. UL 1077

Abstract

There are a great many circuit protection specifications and specification writing agencies that have an impact on the manufacturer and user. They range from the U.S. military to international agencies like IEC. Key specifications are regulatory agency Underwriters Laboratories' (UL) Standards for Safety for low-voltage overcurrent protection devices. The differences in UL services related to circuit protection devices and the requirements and test parameters of UL 489 – the standard for Molded-Case Circuit Breakers, and UL 1077 – the standard for Supplementary Protectors for Use in Electrical Equipment are compared.

UL489 and UL1077

The focus of this MP Technical Brief is the regulatory agency Underwriters Laboratories' (UL) Standards for Safety for low-voltage overcurrent protection devices. As such, we will review the differences in UL services related to circuit protection devices by comparing the requirements and test parameters of UL 489 – the standard for Molded-Case Circuit Breakers, and UL 1077 – the standard for Supplementary Protectors for Use in Electrical Equipment.

Under the standards of UL, most circuit protection devices are investigated and covered by UL's Recognition or Listing services. In both cases follow-up services are used to insure continued compliance.

Under the UL services, Molded-Case Circuit Breakers are evaluated and "Listed" to UL 489 for use as a standalone product and the UL follow-up service tests the devices (typically 2-4 times per year) to the original test specification.

By contrast, "Recognized" devices under UL 1077, Supplementary Protectors for Use in Electrical Equipment, are evaluated only for use as components in Listed products, with the UL follow-up service checking to ensure that the materials and design used in manufacture remains consistent with the original Recognized device.

UL 489 and UL 1077 require the same general types of testing. However, the severity of the test parameters varies with intended use and standard under which a device is covered. To limit the scope of this paper, only the general testing required by these standards will be addressed. For deeper insight, the reader may obtain copies of UL 489 and UL1077 from UL.

While the order of testing may vary with the standard, **Table 1** herein presents the requirements for each standard, UL 489 and UL 1077. Devices with optional features, such as auxiliary contacts, require additional testing.

Review of Table 1 Tests

Calibration – With Circuit Breakers (UL 489) the trip current rating is fixed at 135%, whereas for Supplementary Circuit Protectors, (UL 1077) the trip current rating may be specified by the manufacturer. The significance of this is discussed under **Impact of Manufacturer Specified Protector Parameters.**

Overload – There are two important points worthy of discussion in this section:

1. On Circuit Breakers (UL 489) of ratings below 25 Amps, the overload current is especially severe due to the 150 Amp minimum, versus the normal six times rating. All breakers are tested to this value, which represents usage on inductive/motor-starting applications.

2. On Supplementary Circuit Protectors (UL 1077), the manufacturer has the option of qualifying for inductive/motor-starting applications, or just for general purpose loads. Again, the impact of this choice is discussed under **Impact of Manufacturer Specified Protector Parameters.**

Short Circuit – Again, the Circuit Breaker (UL 489) has the test value rigidly defined, whereas the Supplementary Circuit Protector (UL 1077) values are left to a suggested table or the manufacturer's specified values. This variation can have impact on the proper device selection.

Dielectric Withstand – While the voltage value used is the same for both types, the application points and test sequences are important to note. In many cases a voltage is not applied across open contacts on the supplementary protector, and it is not necessarily required that the dielectric test be performed following a short circuit test. Simply, the supplementary protector is to be used in applications where it is backed up with a circuit breaker or fuse, which will compensate for any breakdown.

Impact of Manufacturer Specified Protector Parameters

As noted above in the discussion of **Table 1**, manufacturers may specify the test parameters on the Calibration, Overload and Short Circuit tests for supplementary protectors. This results in a myriad of possible performance variations, leading to the conclusion that "not all supplementary circuit protectors are created equal". However, with any circuit breaker one knows exactly how it was tested and what performance to expect.

Unfortunately, UL does not publish all the test parameters used on each type of "Recognized" supplementary protector. Therefore, detailed product comparisons can only be made by examining each manufacturer's data sheets. And often, that examination is inconclusive and may lead to misapplication of the device or rejection of UL Listing for the entire end product upon submission to UL.

When an end product containing a supplementary protector is submitted to UL for Listing, it is the responsibility of the UL engineer to review the reports of the Recognized Components used to assure they meet the parameters of the Listed end product's specification.

One of the most serious misapplications is the use of a general load rated supplementary protector in an inductive/motor load application. The contacts in a general load rated protector usually will not support the high inrush nor the severe arcing-on-break associated with an inductive/motor load. Damage caused by these factors may lead to contact welding, increased terminal temperatures and insulation damage, and/or dielectric breakdown. With a few exceptions, most MP supplementary protectors are rated for inductive/motor load applications, but data sheets should be reviewed for a comprehensive understanding of a particular device's performance qualifications.

Another serious consequence may occur when a supplementary protector, specified and tested at a certain level of short circuit current, finds its way into a circuit capable of significantly higher faults. Should this occur, the potential exists for the protector to blow apart, or expel hot material around the operating handle, which could pose a hazard to personnel and property. MP's various UL1077 qualified supplementary protectors have short circuit ratings among the highest in the industry (see data sheets). As another alternative, MP's 752 and 252 Series are the smallest UL 489 Listed and Recognized devices available with a 5,000 Amp short circuit rating

And finally, one last possible consequence involves the inability of different supplementary protectors to trip at the same current levels due to calibration differences. As an example, consider two different manufacturers' 15 Amp rated supplementary protectors, one with a triprating of 135%, and one with a trip-rating of 150%. By specification, the first device must trip within one hour with 20.25 Amps applied. The second unit is required to trip at 22.5 Amps within one hour. The possibility is very real that a 22 Amp overload may be undetected by the second device, and ultimately result in wire insulation damage. With a few exceptions, most of MP's devices are calibrated to tripratings of 125% or 135%, but data sheets should always be reviewed for a comprehensive understanding of a particular device's qualifications.

In conclusion, a design engineer needs to recognize that "not all circuit protection devices are created equal" and that the UL Standard for a Listed end product may require very specific levels of circuit protection.

To these ends, it should be noted that there are differences in the testing and follow up service that UL conducts for Molded-Case Circuit Breakers (UL 489) and Supplementary Protectors (UL 1077). And, within the requirements of UL 1077, each manufacturer has a great deal of latitude in defining the actual levels of performance their protector is evaluated to by UL. Without a comprehensive review of these devices, the potential exists for inadvertently misapplying an under-specified protector, creating a potentially hazardous situation, possibly resulting in end product Listing delays.

Table 1

Test Parameters For Basic Non-Temperature Compensated Circuit Protection Devices

Test	UL 489 Parameter	UL 1077 Parameter
Calibration	100% of rating – hold 135% of rating - trip in one hour (≤50A) 200% of rating - trip in 2 min. max. (≤30A)	100% of rating - hold Manufacturer specifies trip rating 300% of rating –trip within trip curve limits of manufacturer
Overload	50 cycles at 600% of rated current or 150 Amps minimum at .4-.5 lagging power factor (pf)	50 cycles at 600% of rated current at .4-.5 pf for motor/inductive load or 50 cycles at 150% of rated current at .75-.80 pf for general loads
Endurance (switching devices only)	6,000 cycles at 100% of rated current at .75-.8 pf + 4,000 mechanical no-load cycles	6,000 cycles at 100% of rated current at .75-.8 pf
Dielectric Voltage-Withstand	1,000 volts + 2X rated voltage between: A) Live parts and the metal mounting surface or enclosure with the breaker both opened and closed. B) Across line/load terminals with the breaker open	Test not always required, but if performed then: A) Same as UL 489 B) Lower voltage than UL489 and only performed for certain short circuit ratings
Short Circuit	5,000 Amps minimum (higher for breakers rated over 100A or 250V), power factor of .4-.5, must operate at 200% after 3 short circuit operations.	Suggested table value of 200-5,000 Amps depending on ratings at .75-.8 pf or as specified by manufacturer. May not operate after short circuit, as defined by manufacturer

Tests for DC rated devices are similar except motor/inductive load rating for UL1077 Overload is performed at 1,000% of breaker rating, and there is no power factor involved on any test.

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