

CLEARING UP THE CONFUSION:

Specifications and Standards
for Circuit Breakers and
Supplementary Protectors

E-T-A Circuit Breakers

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vive short-circuit testing and continue to provide future overload protection. In service entrance panels, available short-circuit fault currents measure 50,000A or greater. However, as power is distributed throughout a building, the available short-circuit currents diminish. If an electrical outlet is just 20 feet away from the power source, Ohm's law states even with limitless available short-circuit current AWG 14 copper wire limits the maximum available fault current at the outlet to no more than 1200A at 120V.

Supplementary Protection

Although the NEC recognizes "supplementary overcurrent protection used for lighting fixtures, appliances and other equipment or for internal circuits and components of equipment," it does not specifically define supplementary overcurrent protection. Nonetheless, the NEC implies that it is used in conjunction (in series) with a branch circuit overcurrent device upstream of the equipment. The requirements of supplementary protectors are described in UL 1077, "Standard for Supplementary Protectors for Use in Electrical Equipment."

UL 1077

UL 1077 defines supplementary protectors as devices intended for use as overcurrent, over-voltage or under-voltage protection within an appliance or other electrical equipment where branch circuit overcurrent protection is already provided or is not required. In UL terms, UL 1077 compliant devices are labeled as *recognized components*.

Similar to UL 489, UL 1077 supplementary protectors must pass a series of calibration, overload, endurance and short-circuit tests. (See Figure 1.) Because most UL 1077 circuit breakers are rated 20A or less and are used in electrical appliances or other types of utilization equipment, the overload and short-circuit tests are generally performed at lower levels than those required by UL 489. To pass the short-circuit test under UL 1077, the device must safely interrupt short-circuits at least one time without causing a fire hazard. Unlike UL 489, it does not necessarily need to survive the test. In 1999, UL introduced a new category to UL 1077 that includes survivability and recalibration approvals.

Not All UL 1077 Supplementary Protectors Are Alike

UL 1077 allows manufacturers to obtain approval for different circuit conditions. For example, an overcurrent supplementary protector can be short-circuit tested with or without a backup fuse or circuit breaker. A supplementary protector can be overload tested at 1.5 times its rating for general use or 6 times its rating for across-the-line motor starting. It may trip at less than 125 percent of its rating or greater than 135 percent, etc.

“Fit For Further Use”

When UL 1077 was revised to meet changing market requirements and safety considerations, UL added a category of overcurrent supplementary protectors known as “recalibrated after short-circuit testing” which are also described as “fit for further use.”

Overcurrent supplementary protectors rated “fit for further use” survive a three cycle short-circuit test and continue to provide overload and short-circuit protection in future operations. Not all manufacturers of UL 1077 approved circuit breakers strive to meet this more stringent classification. Before selecting a manufacturer, it is essential for the design engineer to verify which tests the circuit breakers are subjected to. If the data sheet provided by the manufacturer does not provide this information, the UL Recognized Component Directory for Supplementary Protectors can be used as a reference in determining the suitability of the protectors as “fit for further use” and/or for motor starting applications, etc.

Below is an example of the UL Recognized Component Directory for Supplementary Protectors. Included is a definition of each code pertaining to the supplementary protector.

Catalog #	412 (G)	
Type	OC	An overcurrent type protector
UG	B, D	Intended for commercial or household appliances
FW	0	Terminals fixed from factory
Max V	28 DC	Maximum voltage either AC or DC
Max Amps	0.1 - 35	Range of current ratings
TC	2	Tripping current more than 135%
OL	0	Overload test performed at 150%
SC	6 KA, U, 2	Short-circuit test performed at 6,000A without series overcurrent protection, recalibration test performed after short-circuit, "fit for further use"

UL Recognized Component Directory for Supplementary Protectors

It is the duty of the design engineer to select the proper supplementary protector for the application to ensure optimal safety and reliability.

A Brief Comparison of UL 489 and UL 1077 Test Standards and Requirements

	UL 1077	UL 489
MINIMUM TERMINAL SPACING	For commercial appliances 3/32 inch up to 300 V 1/4 inch at terminals	1/2 inch up to 130 V 3/4 inch up to 300 V 1 inch up to 600 V through air
CALIBRATION TEST	@ 300% and @ trip current +5%	varies with current rating 12 seconds to 2 minutes @ 200%, <1 hour @ 135% (<50A), <2 hours @ 135% (>50A)
MAXIMUM TEMPERATURE RISE AT TERMINAL	50°C / 122°F	50°C / 122°F
OVERLOAD TEST	50 cycles @ 1.5 x I _N (general use) @ 6 x I _N (across-the-line motor starting)	50 cycles @ 6 x I _N or 150 A minimum
ENDURANCE TEST	6,000 cycles @ I _N (S-type only)	10,000 cycles (6,000 @ I _N + 4,000 mechanical (up to 100A)
SHORT-CIRCUIT TEST	1-3 times (C-0-0) at 5,000A or less, depends on current and voltage (may fail safe or recalibrate after short-circuit tests for "fit for further use")	Depends on ratings. 3-7 times @ 5000A minimum + must operate @ 200% final test

Figure 1

Most supplementary protectors are used in electrical or electronic equipment that is plugged into an outlet. The outlet is wired to a UL 489 listed circuit breaker in an electrical distribution panelboard. Since the distance between the panelboard and the outlet can easily be 50 feet or more, the resistance of 50 feet of AWG 12 or 14 wiring reduces the available short-circuit current at the outlet to well under 1000A.

When the continuous current rating of equipment exceeds 20A and is hard wired to the electrical distribution panelboard, or has a convenience outlet for service and test equipment, the meanings of branch circuit and branch circuit protection become blurred.

Prior to the publication of the “fit for further use” standard, inspectors were uncertain if the supplementary protectors in industrial and commercial equipment would adequately protect certain loads after short-circuit faults. As a result, some local governing authorities began to require branch circuit protection within utilization equipment. Because the term branch circuit protection is interpreted as requiring a UL listed device, UL 489 circuit breakers are being used in equipment that would be better protected by “fit for further use” rated UL 1077 supplementary protectors.

In order to meet the requirement for branch circuit protection as well as for economic and convenience reasons, a manufacturer may replace an 8A supplementary protector circuit breaker with a 15A listed circuit breaker. The manufacturer meets requirements and may gain additional short-circuit protection; however, overload protection is lost. If the circuit is a motor load or other type of load where overloads often occur, conditions such as a locked rotor may go unnoticed and unprotected causing motor failure or, worse yet, overheating of wire insulation, fires and catastrophic short-circuits.

In contrast, a “fit for further use” UL 1077 supplementary protector will protect the equipment during short-circuits and during common overloads.

UL 489A

In the same way the “fit for further use” classification was created to address real world applications, UL 489A is an outline of investigation established in response to the needs of communications equipment. Communications equipment, such as a telecommunication base station, uses DC rather than AC power. Low voltage DC fault currents are far more sensitive to resistance than AC currents. In most telecommunications applications, a circuit breaker with 2000A interrupting capacity is more than adequate, yet UL 489 requires a

minimum interrupting capacity of 5000A. UL 489A addresses this concern by allowing such ratings to be determined by the user and device manufacturer.

Conclusion

As electrical and electronic equipment increases in complexity, it is necessary to protect the operator from the effects of equipment failure and protect the equipment from costly damage and downtime. With a clear understanding of UL standards and requirements, the design engineer is assured optimal performance and safety.

UL 1077 supplementary protector circuit breakers are available from E-T-A in current ratings from 0.05A to 500A and in voltage ratings up to 600V. Several E-T-A UL 1077 circuit breakers are now approved as “fit for further use” and are available in a variety of current ratings. In addition to adequate short-circuit protection, these circuit breakers are sized for precise, continuous current levels protecting equipment from premature failure due to overloads.

About E-T-A

E-T-A Circuit Breakers is the world’s leading manufacturer of circuit breakers for OEM equipment and is the only resource for all circuit protection technologies: thermal, thermal-magnetic, magnetic and high performance. E-T-A circuit breakers are available in more than 150 models and 350,000 different configurations. E-T-A is also a world-leading manufacturer of control products, and solid-state remote power controllers (SSRPCs). With the North American headquarters in Chicago, the company serves industrial OEMs and end-users.

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