ANSI® C37 Standard and UL® 489 Standard Comparison

EVOLUTION OF PRODUCTS AND MARKETS

Since Ben Franklin discovered electricity, people have been struggling to harness its energy and use it safely. As the use of electricity spread into residences and commercial businesses, the need for personal safety and protection against fires became clear.

People needed products that were safe to use and afforded protection against the hazards of fire. They used electricity in their homes and businesses but were not trained to determine the types of products they needed to protect themselves and their property.

Underwriters Laboratories Inc.® (UL®)

Underwriters Laboratories Inc. (UL), was set up in the late 1800s to test many products for the insurance industry. Fire safety and prevention were a major concern. UL, working with electrical manufacturers, developed standards for electrical products and provided third-party certification assuring that the products provide safe and intended functionality regardless of manufacturer. The products began as safety switches evolving into circuit breakers and load centers.

The molded case circuit breakers designed for this market are Listed to the UL 489 Standard. UL 489 requires that these circuit breakers meet specific construction and testing requirements to provide necessary protection while requiring little or no maintenance. One important feature of these types of circuit breakers is the enclosed molded case which provides personal safety as well as assuring proper dielectric clearances.

The American National Standards Institute® (ANSI®)

As the need and dependence on electricity grew, power generation along with large industrial users and continuous process industries became a large part of our industrial complex. Safety and fire prevention were major considerations but continuity of service and equipment performance were also primary requirements. These users had highly trained staffs that worked with manufacturers and the International Electrical and Electronics Engineers, Inc. (IEEE®) committee to design, test and produce electrical equipment that provided the safety, performance and continuity of service they required.

The American National Standards Institute (ANSI) compiled these accumulated design and test documents, provided by IEEE and manufacturers, into ANSI Standards. These standards then became the basis for designing and testing low-voltage power circuit breakers (LVPCBs) and switchgear.

Switchgear is designed with strict standards for compartmentalization, drawout construction and steel barriers between circuit breaker, bus and instrument compartments. Because of the compartmentalization and barriers, LVPCBs were designed with an open construction to allow for strength, heat dissipation and maintenance that was necessary for long service life.

CIRCUIT BREAKER AND EQUIPMENT STANDARDS

UL incorporated ANSI Standard C37 into the UL 1558 Standard for switchgear in 1982 and into the UL 1066 standard for low-voltage power circuit breakers in 1985. These two UL standards provide the basis for third-party witnessing and certification to the ANSI Standard.

Circuit Breaker Standards
- UL 489
- ANSI C37.13 and C37.50 or UL 1066

Equipment Standards
- UL67 Panelboards
- UL 891 Switchboards
- ANSI Switchgear or UL1558 Switchgear or UL 891 Switchboards

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DIFFERENCES BETWEEN THE UL 489 STANDARD AND THE ANSI C37 STANDARD

The UL and ANSI Standards differ in four basic areas:
- Philosophy
- Construction
- Performance testing
- Certification

Philosophy

UL 489 Standard Design and Test Philosophy

The scope of the UL 489 Molded Case Circuit Breaker Standard includes miniature circuit breakers (MCBs), molded case circuit breakers (MCCBs) and insulated case circuit breakers (ICCBs). These circuit breakers are typically rated 10–6000 A and up to 600 Vac and 500 Vdc. Circuit breakers designed and tested to this standard typically exhibit the following characteristics:
- Sealed molded case
- Little or no maintenance
- No user replaceable parts
- Good performance and reliability
- Long service life

ANSI C37 Standard Design and Test Philosophy

The scope of the ANSI C37 Low Voltage Power Circuit Breaker Standard includes 2- or 3-pole stationary and drawout circuit breakers. The specifications of these circuit breakers are 254, 508 or 635 Vac maximum, fused or unfused, and manually- or power-operated with or without electromechanical or electronic trip units. These circuit breakers typically exhibit the following characteristics:
- Iron frame—older designs are open, newer designs are closed
- Maintainable for long service life
- Most parts can be replaced in the field
- High performance and reliability
- High maintenance costs

Construction

The main construction differences between UL 489 Listed and ANSI C37 Certified circuit breakers are maintainability, ampere interrupting ratings (AIRs), heat rise and endurance. These construction differences result from the design and test philosophies outlined above. These differences will be discussed under Performance Testing.

UL 489 Listed circuit breakers are sealed and require no maintenance for a long service life. ANSI C37 Certified circuit breakers typically require maintenance for long life and have been designed with an open case to facilitate maintenance.

Performance Testing

The UL 489 and ANSI C37 Standards require the same basic tests including the following:
- Dielectric
- Calibration
- Overload
- Temperature
- Endurance
- Short circuit

Both the UL 489 and ANSI C37 Standards demonstrate the circuit breaker’s ability to protect conductors under overload or short-circuit conditions. The major differences in performance testing occur during the details and sequences of the tests for overload, temperature, endurance and short-circuit conditions.
Overload Testing
Overload testing is done to demonstrate making and breaking current values that might be obtained when initially energizing a motor load. Each time the circuit breaker is closed and opened on a high current load (600%), the contact surfaces are subjected to arcing and heat. This action simulates an accelerated life test to make sure the contacts provide adequate conductivity through many operations. The UL 489 Standard tests all circuit breaker ratings with significant operations to ensure the design is capable of a long service life with no maintenance. The ANSI C37 Standard tests circuit breakers rated only up to 2000 A.

Temperature Testing
The UL 489 Standard allows for two types of ratings. Standard circuit breakers cannot exceed a maximum of 50°C temperature rise at the wire terminal connection at 100% current in 40°C open air. 100% rated circuit breakers may have a temperature rise of 60°C at the wire terminal connection in the smallest allowable enclosure if the circuit breakers are connected with wire rated at 90°C wiring insulation sized to the 75°C chart (Table 310-16, National Electric Code®—NEC®). The ANSI C37 Standard requires a maximum of 55°C temperature rise at 100% in the smallest enclosure and a maximum of 85°C temperature rise on the contacts.

Endurance Testing
Circuit breakers tested to the UL 489 Standard must pass a significant number of operations without any maintenance. This test verifies that the design is capable of a long service life. The ANSI C37 Standard tests circuit breakers for further operations but then allows for maintenance of the circuit breaker at relatively short intervals.

NOTE: No manufacturer currently offers 225 A or 600 A frame circuit breakers tested to ANSI C37.

Short-circuit Testing
The short-circuit tests reflect differences in the philosophies between the UL and ANSI circuit breaker standards. The UL 489 Standard requires that the tests be conducted at several values of short-circuit current. A separate test sequence evaluates the maximum interrupting rating claimed by the manufacturer. Tests are conducted at the rated voltage(s) of the circuit breaker which is typically 240, 480 or 600 V.
Three-pole circuit breakers are tested under three-phase conditions during the maximum interrupting ability sequence. Each pole is tested individually at a reduced current level. The circuit breaker must safely interrupt the short-circuit current and protect the rated wire in the circuit.

The ANSI C37 Standard requires that a three-pole circuit breaker be tested under three-phase conditions at the maximum interrupting rating and also that each individual pole be tested at 87% of the maximum interrupting rating. Both the three-phase and the individual-pole tests are conducted at rated maximum voltages of 254, 508 and 635 V. The ANSI C37 Standard also includes a separate sequence to evaluate the short-time withstand current of the circuit breaker. The short-time withstand current is a high-level current that can be maintained for 0.5 seconds without damage to the circuit breaker.

### Certification

Certification tests to the UL 489 Standard are witnessed by UL engineering representatives. At the successful completion of the test program, UL permits circuit breakers to bear a UL Listing mark combined with the product identity of “CIRCUIT BREAKER” or “CIRCUIT BREAKER FRAME.” These circuit breakers are then required to undergo subsequent follow-up testing on a regular basis: quarterly, semiannually or biannually depending on the circuit breaker size and quantities produced. All follow-up tests are witnessed by UL field representatives.

Certification tests to the UL 1066 Standard (which include the requirements of the ANSI C37 Standard) are witnessed by UL engineering representatives. At the successful completion of both UL test programs, UL permits the circuit breaker to bear a UL Listing mark combined with the product identity of “LOW VOLTAGE AC POWER CIRCUIT BREAKER” or “LOW VOLTAGE AC POWER CIRCUIT BREAKER FRAME.” While UL conducts follow-up inspections on the UL 1066 Standard tested products to ensure that the construction has not changed from that which was originally tested, they do not require subsequent follow-up testing.

<table>
<thead>
<tr>
<th>Short Circuit</th>
<th>UL 489</th>
<th>ANSI C37</th>
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<tbody>
<tr>
<td>Power factor</td>
<td>≤10,000 A</td>
<td>0.45–0.50</td>
</tr>
<tr>
<td></td>
<td>10,001–20,000 A</td>
<td>0.25–0.30</td>
</tr>
<tr>
<td></td>
<td>≥ 20,000 A</td>
<td>0.15–0.20</td>
</tr>
<tr>
<td>Voltage and current</td>
<td>Rated voltage with low-, medium- and high-level current</td>
<td>Rated current at the three voltage levels: 254, 508 and 635 Vac</td>
</tr>
<tr>
<td>Operations</td>
<td>Open—close/open on all three poles</td>
<td>Open—close/open on all three poles. First open at closing angle to ensure peak current of 2.3 x rated current in one phase</td>
</tr>
<tr>
<td></td>
<td>Open—close/open on each individual pole at reduced current level</td>
<td>Open—close/open individual pole at 87% of rated current</td>
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<td></td>
<td>Short-time withstand—first ON cycle, closing angle must ensure a peak current of 2.3 x rated current in one phase. Circuit breaker remains closed, tripping disabled—0.5 sec. ON, 15 sec. OFF. 0.5 sec. ON</td>
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