AMERICAN NATIONAL STANDARD

American National Standard

ANSI C37.17-1997

AMERICAN NATIONAL STANDARD FOR TRIP DEVICES FOR AC AND GENERAL PURPOSE DC LOW VOLTAGE POWER CIRCUIT BREAKERS

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Secretariat

Institute of Electrical and Electronics Engineers
National Electrical Manufacturers Association

Approved

American National Standards Institute, Inc.

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Foreword (This foreword is not part of ANSI C37.17-1997.)

This standard supersedes and updates the 1979 edition and all previous revised editions of the original standard published in 1956, all written by the National Electrical Manufacturers Association.

This standard pertains to direct-acting over current, reverse-current, and undervoltage trip devices of both the electro-mechanical and electronic types integral with low-voltage AC and general purpose DC circuit breakers covered by American National Standards.

Requirements and references for electro-mechanical devices are included for historical continuity.

This standard does not apply to molded case circuit breakers.

Suggestions for the improvement of this standard will be welcome. They should be sent to the Vice President, Engineering Department, National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209.

This standard was processed and approved for submittal to ANSI by Accredited Standards Committee on Power Switchgear C37. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time of its approval, the C37 Committee had the following members:

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A.K. McCabe, Executive Vice-Chairman, HV Standards
J. Scott, Executive Vice-Chairman, LV Standards
D.L. Swindler, Executive Vice-Chairman, IEC Activities
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The following members of NEMA Power Switchgear Assemblies Technical Committee worked on this standard prior to its publication:

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for Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers

1 General

1.1 Scope

This standard pertains to:

1. direct-acting overcurrent electro-mechanical trip devices
2. direct-acting overcurrent electronic trip devices
3. reverse-current trip devices
4. undervoltage trip devices

that are integral with low voltage AC and DC power circuit breakers covered byANSI/IEEE C37.13, ANSI/IEEE C37.14, and ANSI C37.16.

1.2 References

The following American National Standards are referred to throughout this standard. When any of these standards are superseded by a revision approved by the American National Standards Institute, the revision shall apply.

ANSI/IEEE C37.13-1990, *Low Voltage AC Power Circuit Breakers Used in Enclosures.*
ANSI/IEEE C37.14-1992, *Low Voltage DC Power Circuit Breakers Used in Enclosures.*
ANSI C37.16-1997, *Preferred Ratings, Related Requirements and Application Recommendations for Low Voltage Power Circuit Breakers and Power Circuit Protectors.*
ANSI C37.50-1989 (R1995), *Standard Test Procedures for Low-Voltage AC Circuit Breakers Used in Enclosures.*
ANSI/IEEE C37.90.1-1989, *Surge Withstand Capability.*
ANSI/IEEE C37.90.2-1987, *Withstand Capability of Relay Systems to Radiated Electromagnetic Interference—Trial Use Document.*
ANSI C37.100-1992, *Definitions for Power Switchgear.*
ANSI/NFPA 70-1996, *National Electrical Code.*

2 Service conditions

For service conditions, depending on the type of low voltage power circuit breaker and its application, refer to ANSI/IEEE C37.13, or ANSI/IEEE C37.14.

3 Definitions

The definition of terms in this document or in other American National Standards referred to in this document are not intended to embrace all legitimate means of the terms. They are applicable only to the subject treated in this document.

An asterisk (*) indicates that at the time this standard was approved, there was no corresponding definition in ANSI/IEEE C37.100, while a dagger (†) indicates the definition differs from that in ANSI/IEEE C37.100. For additional definitions see ANSI/IEEE C37.13 and C37.14.

Current sensor

A current transforming device, similar to a current transformer, designed specifically for use with electronic trip device systems, which provides an output signal or signals related to the primary current. The current sensor may include one or more windings. The output signal or signals of any winding of the current sensor may be voltage and or current, dependent on the trip device system design.*

Direct-acting overcurrent trip device (electromechanical)

A release or tripping system that is completely self contained in a circuit breaker and which requires no external power or control circuits to cause it to function and is activated by the electromagnetic forces produced by the current flowing through the circuit breaker. (*)

Direct-acting overcurrent trip device (electronic)

A release or tripping system that is completely self contained in a circuit breaker and which requires no external power or control circuits to cause it to function, and is activated by means of analog or digital processing of a sampling of the current flowing through the circuit breaker. Information functions, if provided may require external power and/or control circuits. The direct-acting overcurrent trip devices may include ground trip elements. *

Direct-acting overcurrent trip device current setting

The value of the current setting on which the long time delay phase trip function is based.*

Dual trip device

A dual trip device shall consist of: (1) A long-time-delay trip function and (2) A high-range instantaneous trip function. (†)

Ground fault trip element with memory

A ground trip element that responds to an intermittent fault to ground by integrating the magnitude of the ground arcing current over time. This produces a trip command when the integrated magnitude exceeds its threshold level unless the time duration of a current magnitude below the pick up setting exceeds a time period specified by the manufacturer.*

Low energy trip actuator

A device which functions to open the circuit breaker mechanically when an electrical signal from the electronic direct-acting overcurrent trip device initiates operation. It shall not require external power to operate.*

Selective trip device

A selective trip device shall consist of: (1) A long-time-delay trip function and (2) A short-time-delay trip function.(†)

Triple selective trip device

A triple selective trip device shall consist of: (1) A long-time-delay trip function; (2) A short-time-delay trip function; and, (3) A high-range instantaneous trip function.*

Zone protective interlocking

A selective trip system which obtains shorter tripping times within a zone by external wiring or electronic communication between two or more circuit breakers. The upstream breaker trips sooner for a fault within the protective zone than it does when providing normal selective backup protection for faults beyond the downstream circuit breaker(s).*

4 Preferred trip device current ratings or settings (amperes)

Refer to table 22 of ANSI C37.16.

5 Types and response of direct-acting overcurrent trip devices

Direct-acting overcurrent trip devices usually consist of a combination of trip functions as described in this standard and as listed below. Ground trip functions may be added to any of these combinations.

5.4 Instantaneous trip device (for general purpose DC power circuit breakers)

An instantaneous trip device shall consist of a low-range instantaneous trip function.

Note: An instantaneous only trip device does not protect equipment from overloads, or low magnitude short circuits.

5.5 Zone protective interlocking

Zone protective interlocking shall provide shorter tripping time(s) for upstream circuit breakers for faults located between two or more circuit breakers, while providing coordination of upstream and downstream circuit breakers for through faults. Zone protective interlocking may operate on the short-time-delay trip function and/or the ground fault trip function. Zone protective interlocking requires communication between the direct-acting trip devices comprising the zone protective interlocking system.

5.6 $I^n t$ modifier for short-time and/or ground faults

The $I^n t$ modifier shall alter the tripping time between the threshold current and the current at which the definite time characteristic is applicable. It fits the general equation $I^n t$ = constant (where n = 2 is generally provided, and t is the tripping time).

6 Calibration of direct-acting overcurrent trip functions

The calibration marks of all overcurrent trip functions represent the rms value of the symmetrical sinusoidal wave shape current, or the average steady state direct-current. The specific calibration marks and the range of values specified below are not restrictive to providing greater ranges and/or additional calibration marks.

If trip functions are non-adjustable, the pick up value shall be properly indicated. Tolerances as specified in 6.1 through 6.6 shall apply.

Note: ANSI/NFPA 70, restricts the maximum setting of the trip elements.

6.1 Low-range instantaneous direct-current trip functions (electro-mechanical devices only)

These trip functions, if adjustable, shall have one or more calibration marks within the range of 50% to 400% of the trip device current rating, with a tolerance of ± 10%.

6.2 High-range instantaneous phase or direct-current trip functions

These trip functions, if adjustable, shall have one or more calibration marks within the range of 300% to 1200% of the trip device current rating, or alternatively, of the trip device current setting, with a tolerance of ± 10 %.

6.3 Long-time-delay phase or direct-current trip functions (electro-mechanical devices only)

These trip elements shall have calibration marks at: 80%, 100% and 125% of the trip device current rating, or alternatively at 80%, 100%, 120%, 140%, and 160%. The tolerance of the marked positions shall be ± 10%.

6.4 Long-time-delay phase trip functions (electronic devices only)

These trip functions shall have at least three calibration marks within the adjustable range of the device. One of the calibration marks shall be at a 100% of the trip device current rating. The tolerance of the marked positions shall be ± 10% or - 0 + 20%.

6.5 Short-time-delay phase or direct-current trip functions

These trip functions shall have one or more calibration marks within the range of 300 to 1000% of the trip device current rating or alternatively, of the trip device current setting within a tolerance of ± 15% or - 0 + 30%.

6.6 Ground trip functions

These trip functions, if adjustable, shall have one or more calibration marks within the range of 20% to 60% of the trip device current rating, or alternatively, of the trip device current setting, within a tolerance of ± 15%.

7 Delay times of direct-acting overcurrent trip functions

7.1 Long-time-delay phase or direct-current trip functions

Delay time shall fall between one or more of the time bands of table 1 or 3.

7.2 Short-time-delay phase or direct-current trip functions

Delay time shall fall within one or more of the time bands of table 2 or 4.

7.3 Short-time-delay ground trip function

Delay time shall fall within one or more of the time delay bands of table 4.

8 Reverse-current trip devices for general purpose direct-current circuit breakers

The pick up of a reverse-current trip device shall have one or more calibration marks from 5% to 50% of the continuous current rating of the circuit breaker. Reverse-current trip devices shall be calibrated at rated voltage and are not required to trip when operating below 70% of rated voltage.

Note: A device must withstand the upper limits of the voltage ranges as shown under the tripping functions of table 23 of ANSI C37.16.

9 Undervoltage trip devices

9.1 Drop-out voltage range

The drop-out voltage range of an undervoltage trip device shall be within 30% to 60% of the voltage rating of the coil for both AC and DC applications.

9.2 Pickup or seal in voltage

An electrically reset undervoltage trip device shall pickup, or a mechanically reset undervoltage trip device shall seal in at 85% or less of the voltage rating of the coil.

9.3 Maximum Operating Voltage

The device must withstand the upper limits of the control voltages for the tripping functions as given in table 23 of ANSI C37.16.

Note: This device is intended to protect for loss of voltage and is not intended for use as an undervoltage relay or anti-single phase protection.

10 Tests

Design and production tests shall be made in accordance with the requirements of ANSI C37.50, or ANSI/IEEE C37.14, as applicable. In addition, the following requirements shall apply:

10.1 Design tests

Design tests shall be made with the trip devices installed on representative circuit breakers installed the test enclosure specified in ANSI C37.50, with the exception that calibration tests may be performed on the individual direct acting trip device prior to installation on the circuit breaker. If the trip device is separately tested, the effect of the operating time of the circuit breaker shall be recognized, and the complete assembly shall be tested to assure that the device will mechanically trip the circuit breaker.

Design tests shall include:

a. Tests as defined in clause 3.4 of ANSI C37.50
b. Trip device calibration test per clause 10.1.1.

10.1.1 Trip device calibration check test

Calibration check tests shall be made to demonstrate the stability of the trip devices. The tripping times shall be in accordance with the requirements of ANSI C37.17 as well as the manufacturer's time-current characteristic curve for the particular device.

Calibration check tests shall include the following, where applicable:

a. Direct-acting trip devices.

   1. Long-time-delay trip elements. The long-time-delay-trip element of the direct acting trip device shall be set at the 100% long-time pickup setting and at the marked minimum time setting (band). The element shall be tested once to determine the time of operation by applying a test current equal to 600% of the 100% setting.

      The 600% test current shall be initiated at the test value or shall be increased from a lower value to the test value as quickly as possible, but no longer than 5 s, and shall be maintained at the test value.

2. Short-time-delay trip elements. The short-time-delay trip element of the direct-acting trip device shall be set at any marked short-time-delay pickup setting and at the marked maximum time setting (band), and shall be tested once to determine the time of operation when a test current equal to 250% of that setting is applied to the trip device.

   The test current shall be initiated and maintained at the test value.

   In addition, each short-time-delay trip element shall be tested to ensure that it will not trip the circuit breaker when a current less than the pickup setting (minus the allowable tolerance) is applied. This current should not be maintained for longer than 1 s.

3. Instantaneous trip elements. The instantaneous trip element of the direct-acting trip device shall be set at any marked pickup setting, and shall be tested once to ensure that the element operates with the allowable tolerance. Compliance with this requirement may be determined by initiating the test current at approximately 70% of the instantaneous trip setting, and quickly raising the current at a uniform rate as rapidly as is consistent with an accurate determination of the trip value.

4. Ground trip elements. The ground trip element of the direct acting trip device shall be set at any marked ground pickup setting and at the maximum time setting (band), and shall be tested once to determine the time of operation when a test current equal to 250% of that setting is applied to the trip device.

   The test current shall be initiated and maintained at the test value.

b. Undervoltage trip device. Check that the device trips the circuit breaker when the voltage falls within the range of 30 to 60% of rated voltage. Determine that the device will permit the circuit breaker to be closed at 85% of rated voltage.

c. Reverse current trip device. Check that the device trips the circuit breaker at its reverse current trip setting and in the proper direction at the rated control voltage.

10.1.2 Electromagnetic compatibility tests

In addition to the tests in 10 above, the following design tests are also required on electronic trip devices:

1. Surge withstand capability tests, performed in accordance with IEEE C37.90.1.

2. Withstand capability to radiated electromagnetic interference performed in accordance with ANSI/IEEE C37.90.2 (an IEEE trial use-standard).

Note: For dielectric test, electronic devices that use the negative bus for ground must be isolated before tests are performed.

10.2 Production tests

All applicable production tests shall be made by the manufacturer at the factory on each circuit breaker after final assembly, except calibration, which may be performed on the individual direct acting trip device prior to installation on the circuit breaker. If the trip device is separately tested, the effect of the operating time of the circuit breaker shall be recognized, and the complete assembly shall be tested to assure that the device will mechanically trip the circuit breaker.

Production tests shall include calibration test per clause 10.2.1

10.2.1 Calibration

Calibration tests shall include the following trip device, where applicable.

10.2.1.1 Direct-acting trip devices

Direct-acting trip devices shall be subjected to the following calibration, where applicable, for conformance to published time-current-characteristic curves. Test current at any convenient voltage may be used. The following calibrations may be performed in any order deemed appropriate by the manufacturer:

a. Long-time-delay element pickup
b. Short-time delay element pickup
c. Instantaneous element pickup
d. Ground element pickup
e. Time delay of long-time-delay element
f. Time delay of short-time-delay element
g. Time delay of ground element

10.2.1.2 Undervoltage trip devices

Each undervoltage trip device shall be calibrated to make sure that it trips the circuit breaker when the voltage drops to a value that falls within the range of 30 to 60% of rated voltage. A test shall be made to determine that the undervoltage trip device, with 85% of rated voltage applied, will permit the circuit breaker to be closed.

For an undervoltage trip device equipped with time delay, the time delay shall also be checked to see that it falls within the manufacturer's specified limits and that the device resets if voltage recovers in the delay period.

10.2.1.3 Reverse-current trip devices

The pickup of a reverse-current trip device shall have one or more calibration marks from 5 to 50% of the continuous current rating of the circuit breaker. Reverse-current trip devices shall be calibrated at rated voltage and are not required to trip when operating below 70% of rated voltage.

Note: A device shall withstand the upper limits of the voltage ranges as shown under the tripping functions of table 23 of ANSI C37.16.

Table 1–Time bands for long-time-delay phase trip functions or direct-current trip functions (electromechanical) (see 6.3 and 7.1)

Percent of Long-Time Pickup Setting	Time Bands	
Tolerance Band ± 10%	Minimum	Maximum
Less than 90[1]	No Trip	No Trip
110	Ultimately Trips	Ultimately Trips
125	Trips in Less than 2 hours	Trips in Less than 2 hours
300	Upper Limit of band[2] 225A frame size, 4 min. 600 A frame size, 6 min. 1600 A frame size, 11 min. Over 1600 A frame size, 12 min.	Upper Limit of band[2] 225A frame size, 4 min. 600 A frame size, 6 min. 1600 A frame size, 11 min. Over 1600 A frame size, 12 min.
600	Lower limit of band, 2s[3]	Lower limit of band, 30s[3]

1 The three-phase performance of devices calibrated single phase may find the "no trip" level as low as 85% and the "ultimately trips" level as high as 115% of the long-time pickup setting.

2 The upper limit of the band represents the time from the start of the overcurrent until interruption by the circuit breaker. The time values apply for the 100% long-time-delay pickup setting. Consult manufacturer for applications at other pickup settings.

3 The lower limit of the band is the time during which the overcurrent may persist at the given value and then drop to 80% of long-time-delay pickup setting without tripping the circuit breaker. The lower limits are the minimum allowable values for each of the time bands. The actual tripping time will always be in excess of the lower limit of the band. The time values apply for the 100% long-time-delay pickup setting with the instantaneous element set to minimize its effect on the long-time-delay.

Table 2–Time bands for short-time-delay phase trip functions or direct-current trip functions (electromechanical) (see 6.5 and 7.2)

Percent of Long-Time Pickup Setting	Time Bands	
Tolerance Band ± 15%	Minimum	Maximum
Less than 85	No Trip	No Trip
115	Ultimately Trips	Ultimately Trips
250	Lower limit of band 0.03s[1]	Lower limit of band 0.20[1]
250	Upper limit of band, seconds[2]	Upper limit of band, seconds[2]

1 The lower limit of the band is the time during which the overcurrent may persist at the given value and then drop to 20% of short-time-delay pickup setting without tripping the circuit breaker by the short time element. The lower limits are the minimum values of each of the three bands. The actual tripping time will always be in excess of the lower limit of the band.

2 The upper limit of the band represents the time from the start of the overcurrent until interruption by the circuit breaker. Discrete values for upper limits are not specified, but upper limits should permit coordination between breakers using properly selected time bands and pickup settings. However, in no case should the value of 0.50s be exceeded at the short-time current rating of the circuit breaker.

Table 3–Time bands for long-time-delay phase trip functions (electronic) (see 6.4 and 7.1)

Percent of Trip Device Current Rating or Pickup		Time Band Range[1]	
Tolerance Band			
± 10%	- 0% + 20%	Minimum	Maximum
Less than 90	Less than 100	No trip	No trip
110	120	Ultimately trips	Ultimately trips
200	200	Trips in less than 80s	Trips in less than 500s
600	600	Lower limit of band 1.5s[2]	Lower limit of band 6s[2]
600	600	Upper limit of band 8s[3]	Upper limit of band 50s[3]

1 Number of bands between maximum and minimum is at the option of the manufacturer
2 The lower limit of the band is the time during which the overcurrent may persist at the given value and then drop to 80% of trip device current rating or long-time pickup setting without tripping the circuit breaker. The lower limits are the minimum allowable values for each of the time bands. The actual tripping time will always be in excess of the lower limit of the band.
3 The upper limit of the band represents the time from the start of the overcurrent until interruption by the circuit breaker.

Table 4–Time bands for short-time-delay phase trip functions or ground trip functions or both (electronic) (see 6.5, 6.6, 7.2 and 7.3)

Percent of Trip Device Current Rating or Pickup		Time Band Range[1]	
Tolerance Band			
± 15%	- 0% + 30%	Minimum	Maximum
Less than 85	Less than 100	No trip	No trip
115	130	Ultimately trips	Ultimately trips
125[2]	140	Trips in less than 0.5s	Trips in less than 2s
250[2]	250	Lower limit of band 0.04s[3]	Lower limit of band 0.30s[3]
250[2]	250	Upper limit of band 0.20s[4]	Upper limit of band 0.50s[4]

1 Number of bands between maximum and minimum is at the option of the manufacturer
2 Without I^nt
3 The lower limit of the band is the time during which the overcurrent may persist at the given value and then drop to 80% of trip device current rating or long-time pickup setting without tripping the circuit breaker. The lower limits are the minimum allowable values for each of the time bands. The actual tripping time will always be in excess of the lower limit of the band.
4 The upper limit of the band represents the time from the start of the overcurrent until interruption by the circuit breaker.