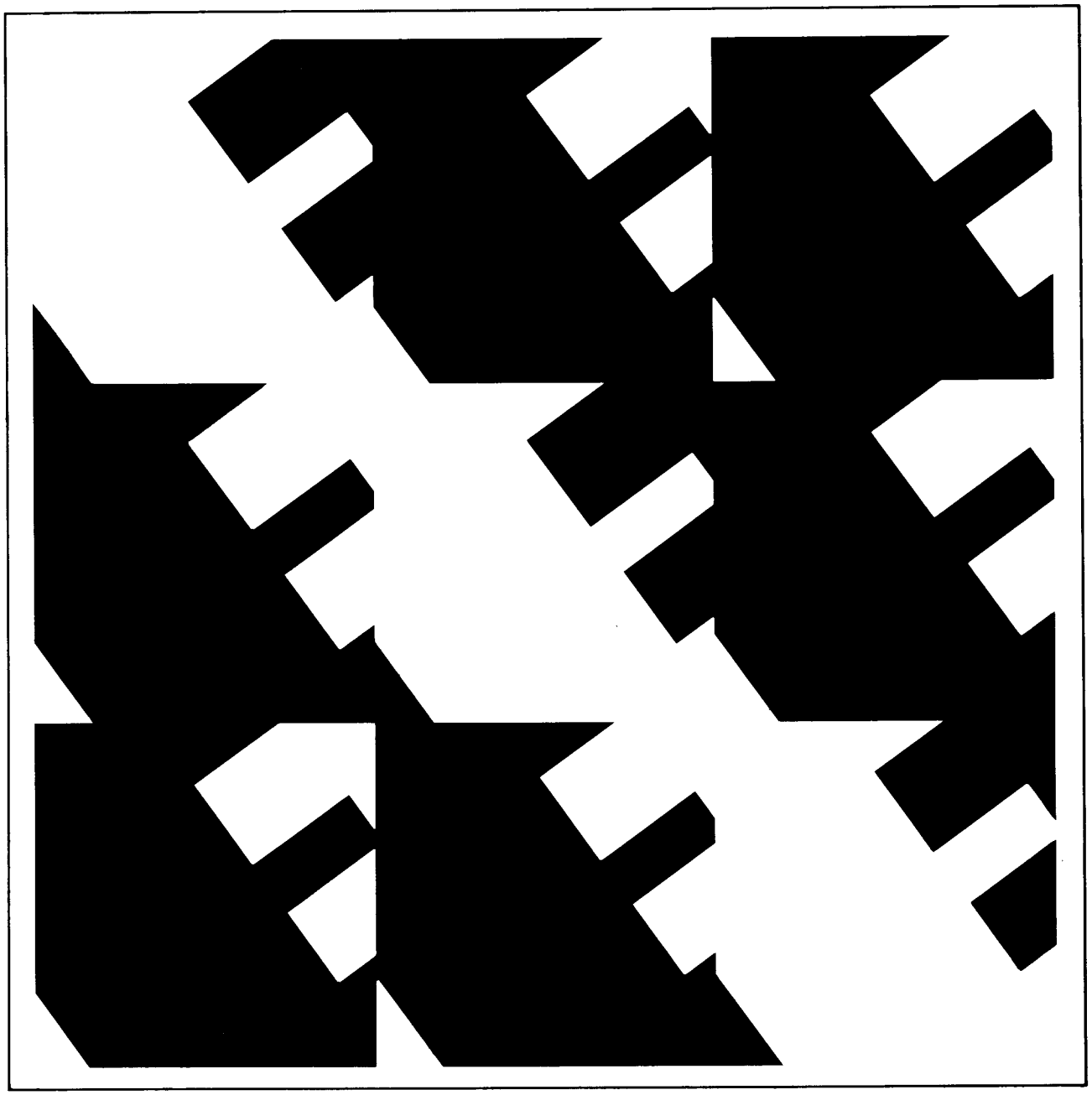
AMERICAN NATIONAL STANDARD

IEEE Guide for Testing Faulted Circuit Indicators



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IEEE Guide for Testing Faulted Circuit Indicators

Sponsor

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IEEE Power Engineering Society**

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**The Institute of Electrical and Electronics Engineers, Inc
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Foreword

(This Foreword is not a part of ANSI/IEEE Std 495-1986, IEEE Guide for Testing Faulted Circuit Indicators.)

This test code was prepared by the Task Group on Test Code for Faulted Circuit Indicators of the Working Group on Switching and Overcurrent Protection, Distribution Subcommittee, IEEE Transmission and Distribution Committee of the IEEE Power Engineering Society. At the time this guide was approved, the task group had the following membership:

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IEEE Guide for Testing Faulted Circuit Indicators

1. Scope and References

1.1 Scope. This test code establishes definitions, service conditions, test procedures, and conditions for faulted circuit indicators (FCI) for use on power distribution systems.

1.2 References

[1] ANSI / IEEE C37.41-1981, IEEE Standard Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.[1]

[2] ANSI / IEEE Std 4-1978, IEEE Standard Techniques for High Voltage Testing.

2. Definitions

fault current. Any current through the sensor equal to or in excess of the trip current of the faulted circuit indicator (FCI).

faulted circuit indicator. A single or multiphase device designed to sense fault current and provide an indication that the fault current has passed through the power conductor(s) at the point where the FCI sensor is installed.

indicator. That portion of the FCI which indicates that fault current has been sensed.

reset current or voltage. The nominal rms value of current or voltage that will cause the indicator of the automatic current or voltage reset FCI to change from FAULT to NORMAL indication.

reset time. The time required for the FCI to return automatically to NORMAL indication after its reset current or voltage has been established, or for the elapsed time automatic reset FCI to reset.

response time. The time required for the FCI to respond to a specified value of fault current.

suitable test. Where a condition or a set of conditions are so variable from one utility to another or even within the utility itself that no test can be properly specified for all conditions, it is left to the user to determine their individual test needs. A suitable test and anticipated service life shall be that which is mutually agreed to between manufacturer and user.

trip current. The actual value of current in amperes rms that will cause the FCI to indicate FAULT.

[1] ANSI documents are available from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

trip current rating. The published rms sinusoidal fault current in amperes which cause the FCI to indicate FAULT.

3. Service Conditions

3.1 Usual Service Conditions

3.1.1 Environment. The FCI shall be suitable for use under one or more of the following service conditions:

(1) In air, exposed to direct sunlight and salt spray

(2) In air, exposed to direct sunlight

(3) In air, not exposed to direct sunlight or salt spray

(4) Buried in earth (sensor only)

(5) Submerged in water intermittently or continuously to a depth of 15 ft

3.1.2 Ambient Temperature

	Ambient Temperature Range	
Class	Sensor	Indicator
All	−40 °C to 85 °C	−40 °C to 85 °C

3.2 Unusual Service Conditions. Service conditions other than those listed in 3.1 are considered to be unusual.

4. Testing

4.1 Design Tests. All tests specified in 4.4 shall be performed by the manufacturer on a sufficient number of FCI's made on production tooling, using production methods to demonstrate that they meet their ratings and are suitable for operation under usual service conditions.

4.2 Production Tests. The following production tests shall be performed by the manufactuer on every FCI:

(1) Trip current test, see 4.4.9

(2) Reset test, see 4.4.10

In addition, the manufacturer shall periodically test a sufficient number of production FCI's to ensure continuing compliance with design tests.

4.3 General Test Conditions. The following test conditions shall apply unless otherwise specified under specific tests:

(1) FCI's shall be properly assembled with actual components. All parts which are grounded in a normal installation shall be connected to the ground of the test circuit

(2) Test temperatures shall be selected by the manufacturer to verify that the FCI will meet its rating under the conditions shown in 3.1.2

(3) All ac voltage shall be in accordance with ANSI/IEEE Std 4-1978 [2].[2]

4.4 Specific Tests

4.4.1 Temperature Cycling Test. The purpose of this test is to ensure that the FCI will operate after aging. The FCI shall be subjected to five sequential thermal cycles with exposures at −40 °C, 50 °C, and 85 °C. Temperature equilibrium shall be achieved at each temperature level for the FCI before cycling can continue. Following these exposures, the FCI shall pass all of the other design tests.

4.4.2 Water Submersion Test. The purpose of this test is to verify that temperature cycling will not adversely affect the ability of the submersible FCI to prevent the entrance of moisture at all interfaces.

The FCI shall be placed under water with an equivalent pressure head of 15 ft of water at a temperature of 20 °C to 30 °C for 48 h. The equivalent pressure head of 15 ft of water shall then be maintained while the water temperature is raised to 70 °C and held for 48 h. The equivalent pressure head of 15 ft of water shall then be maintained as the water temperature is allowed to return naturally to 20 °C to 30 °C and while the water temperature is further lowered to 5 °C. This equivalent pressure head of 15 ft of water and water temperature of 5 °C shall be maintained for 48 h.

The FCI shall be removed from the water and visually examined for moisture inside the indicator and sensor and for any surface deterioration. The temperature of the FCI shall be allowed to return to 20 °C to 30 °C naturally where it shall remain for 3 h. The tests of 4.4.9 and 4.4.10 shall than be applied. The temperature of the FCI shall be raised to 85 °C where it shall remain for 3 h. The temperature of the FCI shall be held at 85 °C and the tests of 4.4.9 and 4.4.10 shall again be applied. The temperature of the FCI shall then be lowered to −20 °C where it shall remain for 3 h. The temperature of the FCI shall be held at −20 °C and the tests of 4.4.9 and 4.4.10 shall again be applied.

[2] Numbers in brackets correspond to those of the references, Section 1.2 of this standard.

4.4.3 Outdoor Weathering of Plastics Test. A suitable test shall be performed to demonstrate that FCI's installed in direct sunlight will perform satisfactorily for their anticipated service life.

4.4.4 Salt Spray Test. A suitable test shall be performed to demonstrate that FCI's installed exposed to salt spray will perform satisfactorily for their anticipated service life.

4.4.5 Immersion Corrosion Test. A suitable test shall be performed to demonstrate that FCI's installed submerged in water or buried in earth will perform satisfactorily for their anticipated service life.

4.4.6 Electric Cord Pull-Out Test. The purpose of this test is to ensure that electric cord strain relief on multipart FCI's can be accomplished so that a force exerted on the flexible cord will not be transmitted to wiring connections. The assembly of a cord and FCI sensor or indicator shall be capable of withstanding a steady straight pull of 30 lb. The detachment of any cord conductor or any other evidence of mechanical or electrical failure is not acceptable.

4.4.7 Impact Resistance Test. The purpose of this test is to ensure that the FCI will not change an indication from NORMAL to FAULT or from FAULT to NORMAL due to normal handling in the field. The FCI shall be mounted per the manufacturer's instructions on number 2 15 kV class concentric neutral cable connected with a 200 A class elbow to a 25 kVA low-profile padmounted transformer with an upward opening hinged lid. The FCI shall not change an indication from FAULT to NORMAL or from NORMAL to FAULT when the transformer lid is slammed open or shut.

4.4.8 Short-Time Current Test. The purpose of this test is to verify that the FCI is capable of withstanding short-time current of one of the magnitude and duration classes as follows:

Fault Current Rating in Amperes	Test Current in Amperes RMS Symmetrical	Time in Seconds	Minimum Assymetry Factor
10 000	10 000	0.17	1.3 (X/R = 6)
25 000	25 000	0.17	1.6 (X/R = 20)

Before imposing the short-time current test, the FCI shall be subjected to all of the other tests covered by 4.1 and shall meet the requirements of those tests. The rms value of the first major loop of the current wave shall be equal to or greater than the symmetric value specified in the table, times the appropriate asymmetry factor. The rms value of the symmetric current shall be equal to or greater than the value specified in the table. This short-time current test shall be applied to the FCI two times, after which the FCI shall successfully pass the tests covered by 4.4.9, 4.4.10, and 4.4.11.

4.4.9 Trip Current Test. The purpose of this test is to verify that the FCI indicator will move from an indication of NORMAL to an indication of FAULT when tested in accordance with 4.4.9 (1) and will not move from an indication of NORMAL to an indication of FAULT when tested in accordance with 4.4.9 (2). If this test is being conducted as a design test, the specimens shall first have passed the short-time current test, 4.4.8.

(1) *Trip Current Rating Verification Test.* This test shall be performed by passing current through the conductor(s) to which the FCI is applied. The results shall demonstrate compliance with the manufacturer's specified trip current rating and tolerances.

The manufacturer shall perform this trip current test at various temperatures throughout the specified temperature range of the FCI with the selection designed to demonstrate compliance with the requirements of this test code. This test shall be performed a minimum of ten times at each temperature selected for design tests and once at 20 °C to 30 °C for production tests.

(2) *Test for Effect of Current Adjacent Conductors.* This test shall verify that the indicator will continue to indicate NORMAL when the FCI is positioned in any orientation no closer than the manufacturer's specified distance to an adjacent unshielded conductor-carrying fault current as specified in either the 10 000 A or 25 000 A class in 4.4.8. The temperature shall be the same as 4.4.9 (1).

4.4.10 Reset Test. If this test is being conducted as a design test, the specimens shall first have passed the short-time current test, 4.4.8.

(1) *Automatic Reset FCI's.* The purpose of this test is to verify that the indicator of an automatic reset FCI will move from an indication of FAULT to an indication of NORMAL within its rated reset time after reset conditions have been established. This reset time should be specified by the manufacturer.

The FCI shall not reset to NORMAL when it is positioned in any orientation no closer than the manufacturer's specified distances to an ad-

jacent unshielded conductor carrying rms current of 200 A, 600 A, and 1200 A. This adjacent cable test is *not* required as a production test.

(a) *Current Reset.* For FCI's that require a current flow through the cable conductor in order to move from an indication of FAULT to an indication of NORMAL, the indicator shall move to an indication of NORMAL when any current over the range of 3% to 80% of the trip current rating flows through the cable conductor for not more than 10 min.

(b) *Voltage Reset.* For FCI's that require a potential to be restored to the cable conductor in order to move the indicator from an indication of FAULT to an indication of NORMAL, the indicator shall move to an indication of NORMAL when minimum reset ac voltage is applied to the cable conductor for not more than 10 min.

The manufacturer shall perform this reset current or voltage test at various temperatures throughout the specified temperature range of the FCI with the selection designed to demonstrate compliance with the requirements of this test code. This test shall be performed a minimum of ten times at each temperature selected for design tests and once at 20 °C to 30 °C for production tests.

(c) *Time Reset.* For FCI's requiring only elapsed time to reset, the FCI shall reset within its rated time and tolerances.

(2) *Manual Reset FCI's.* The purpose of this test is to verify that the indication of a manual reset FCI can be moved from an indication of FAULT to an indication of NORMAL after fault current has been interrupted. The indicator shall move from the FAULT to NORMAL indication when reset by the means specified by the manufacturer.

4.4.11 Time-Current Test. The purpose of this test is to establish reliable operating time-current curves for the FCI and to demonstrate that the FCI will operate within the range of the time-current curves. This test shall be run and data shall be recorded in a manner consistent with that specified for fuses in ANSI / IEEE C37.41-1981 [1]. Time-current tests shall be run down to 0.005 s on FCI's for use with current - limiting fuses. Test conditions and ranges of conditions shall be clearly stated.