

IEEE Standard Test Methods for Surge Protectors Used in Low-Voltage Data, Communications, and Signaling Circuits

Sponsor
Surge-Protective Devices Committee
of the
IEEE Power Engineering Society

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Abstract: Methods are established for testing and measuring the characteristics of surge protectors used in low-voltage data, communications, and signaling circuits with voltages less than or equal to 1000 V rms or 1200 V dc. The surge protectors are designed to limit voltage surges, current surges, or both. The surge protectors covered are multiple-component series or parallel combinations of linear or nonlinear elements. Tests are included for characterizing standby performance, surge-limiting capabilities, and surge lifetime. Packaged single gas-tube, air-gap, varistor, or avalanche junction surge-protective devices are not covered, nor are test methods for low-voltage power circuit applications.

Keywords: communications circuits, data circuits, electrical protection, signaling circuits, surge protectors, surge-protective devices, voltage limiters

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Foreword

(This Foreword is not a part of IEEE C62.36-1991, IEEE Standard Test Methods for Surge Protectors Used in Low-Voltage Data, Communications, and Signaling Circuits).

This standard has been developed for the purpose of establishing methods of testing and criteria for determining end-of-life of surge protectors for use in low-voltage data, communications, and signaling circuits. The surge protectors covered are multiple-component series or parallel combinations of linear or nonlinear elements, packaged for the purpose of limiting voltages or currents, or both.

The need for this standard has arisen because of the following industry trends:

- (1) The development and proliferation of numerous semiconductor surge-protection devices.
- (2) The manufacture and use of multiple-component surge protectors.
- (3) The increasing use of sensitive electronic devices that require protection while exposed to surges from the environment.

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IEEE Standard Test Methods for Surge Protectors Used in Low-Voltage Data, Communications, and Signaling Circuits

1. Scope

This standard applies to surge protectors for application on multiconductor balanced or unbalanced data, communications, and signaling circuits with voltages equal to or less than 1000 V rms, or 1200 V dc. These surge protectors are designed to limit voltage surges, current surges, or both.

This standard describes the methods of testing and criteria for determining the end of life of electrical surge protectors used in low-voltage data, communications, and signaling circuits. The surge protectors covered are multiple-component series or parallel combinations of linear or nonlinear elements, packaged for the purpose of limiting voltage, current, or both.

This standard is not intended to cover packaged single gas tube, air gap, varistor or avalanche junction surge-protective devices, which are included in IEEE C62.31-1987 [2]¹, IEEE C62.32-1981 [3], IEEE C62.33-1982 [4], and IEEE C62.35-1987 [5], respectively. Specifically excluded from this standard are test methods for low-voltage power circuit applications. For protection of wire-line communication facilities under the specialized conditions found at power stations, consult IEEE Std 487-1980 [9].

The tests in this standard are intended as design tests as defined in IEEE Std 100-1988 [7], *IEEE Standard Dictionary of Electrical and Electronics Terms*, and provide a means of comparison among various multiple-component surge protectors.

The test criteria and definitions of this standard provide a common engineering lan-

guage beneficial to users and manufacturers of multiple-component surge protectors.

Because of the voltage and energy levels employed in the majority of tests described herein, all tests should be considered hazardous. Appropriate caution should be taken in their performance.

2. Definitions

This section contains only those definitions relating to surge protectors, within this standard, that are not listed in IEEE Std 100-1988 [7].

surge protector. An assembly of protective devices consisting of one or more series, parallel, or any combination of elements used to limit surge voltages, currents, or both to a specified level. *Syn:* **protector.**

transition current. The current required at a given temperature and duration to cause a current-protective device to change state.

3. References

This standard shall be used in conjunction with the following publications:

[1] IEEE C62.1-1989, IEEE Standard for Gapped Silicon-Carbide Surge Arresters for AC Power Circuits.²

²IEEE publications are available from the Institute of Electrical and Electronics Engineers, Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

¹The numbers in brackets correspond to those of the references in Section 3.

[2] IEEE C62.31-1987, IEEE Standard Test Specifications for Gas-Tube Surge-Protective Devices (ANSI).

[3] IEEE C62.32-1981 (Reaff. 1987), IEEE Standard Test Specifications for Low-Voltage Air Gap Surge-Protective Devices (ANSI).

[4] IEEE C62.33-1982 (Reaff. 1989), IEEE Standard Test Specifications for Varistor Surge-Protective Devices (ANSI).

[5] IEEE C62.35-1987, IEEE Standard Test Specifications for Avalanche Junction Semiconductor Surge-Protective Devices.

[6] IEEE C62.45-1987, IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits (ANSI).

[7] IEEE Std 100-1988, IEEE Standard Dictionary of Electrical and Electronics Terms (ANSI).

[8] IEEE Std 455-1985, IEEE Standard Test Procedure for Measuring Longitudinal Balance of Telephone Equipment Operating in the Voice Band (ANSI).

[9] IEEE Std 487-1980, IEEE Guide for the Protection of Wire Line Communications Facilities Serving Electric Power Stations (ANSI).

[10] IEEE Std 743-1984, IEEE Standard Methods and Equipment for Measuring the Transmission Characteristics of Analog Voice Frequency Circuits (ANSI).

4. Service Conditions

4.1 Normal Service Conditions. In the absence of special requirements, the following items should be specified as appropriate.

4.1.1 Environmental Conditions

- (1) Operating and storage temperature ranges
- (2) Humidity
- (3) Mechanical shock and vibration
- (4) Atmospheric pressure range

4.1.2 Physical Properties

- (1) Solvent resistance
- (2) Solderability
- (3) Flammability
- (4) Package rupture during overload
- (5) Electrical connection to metallic case

4.1.3 System Conditions

- (1) Nominal system frequencies
- (2) Maximum continuous system voltage
- (3) Peak impulse currents
- (4) Transient repetition rate

4.1.4 Surge Rating of the Surge Protector Under System Conditions

- (1) Rated average power dissipation
- (2) Peak pulse power or current temperature derating
- (3) Lifetime rated pulse currents

4.2 Unusual Service Conditions. The following service conditions may require special consideration in the design or application of surge protectors and should be called to the attention of the manufacturer.

4.2.1 Environmental Conditions

- (1) Ambient temperature exceeding the normal service conditions
- (2) Exposure to
 - (a) Damaging fumes or vapors
 - (b) Excessive dirt or current-conducting deposits, excessive humidity, moisture, dripping water, steam or salt spray, explosive atmospheres, abnormal vibrations, and shocks
- (3) Unusual transportation or storage conditions
- (4) Flammability rating

4.2.2 Physical Conditions. Limitation on weight or space, including clearance to nearby conducting objects.

4.2.3 System Conditions

- (1) System voltages, currents, repetition rates, or frequency operating conditions whereby the ratings of the devices are exceeded (see Section 9)
- (2) System impulse currents exceeding the rating of the device (see Section 9)

- (3) Exposure to direct lightning strike (see Section 9)
- (4) Electromagnetic field effects (see Section 9)
- (5) Unusual ground potential situations (see Section 9)
- (6) Any other unusual conditions known to the user

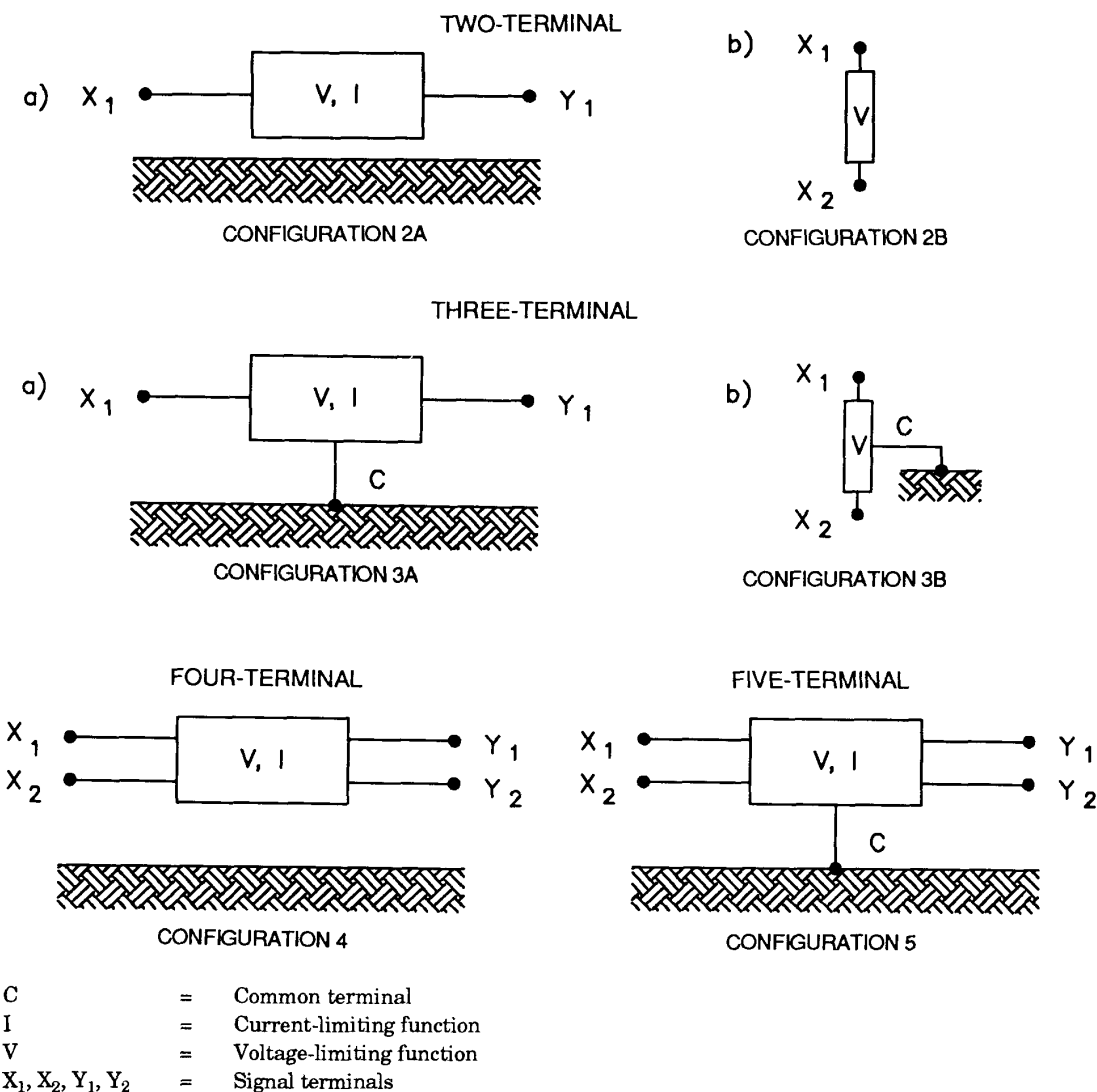
4.3 Radiation. Some protectors may contain radioactive material. Manufacturers of such

protectors shall mark them in accordance with applicable regulations.

5. Basic Configurations

This section illustrates, by functional block diagrams, the surge protectors described by this document. A protector assembly may be composed of any number of the protectors in Fig 1.

Fig 1
Basic Configurations



6. Standard Design Test Procedure

6.1 Standard Design Test Criteria. The design tests described in Sections 7 and 8 provide standardized methods for making single observations of a specified characteristic of a surge protector. These properties may vary from device to device, making it necessary to provide statistical descriptions of the property in order to compare products.

6.2 Statistical Procedures. The following procedure shall be used to describe any characteristic that has been determined to have important statistical aspects. A product sample shall be chosen in a manner consistent with the definition of design tests as provided by IEEE Std 100-1988 [7]. A sufficient number of devices shall be tested and the characteristic or rating in question measured as described in the applicable design test until the parameters of the underlying statistical distribution are determined within specified confidence limits. Values relating to the product sample such as, but not limited to, mean, median, maximum, minimum, and standard deviation may then be stated.

6.3 Test Conditions. The tests in Sections 7 and 8 shall be performed on the surge protector as required by the application. Unless otherwise specified, ambient test conditions shall be as follows:

Temperature: $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$
Relative Humidity: Less than 85%
Atmospheric Pressure: 60 cm to 78 cm of Hg

For temperatures other than 25°C , the surge protector, mounted as intended to be used, shall be maintained at the specified test temperature but with the air flow controlled to provide a free convection heat transfer, unless otherwise specified. The protector temperature shall be allowed to stabilize before tests are performed.

7. Nonsurge Performance Tests

The following nonsurge voltage and current tests are intended to establish that, in its quiescent state, the surge protector does not disturb operation of the protected circuit.

7.1 Rated Voltage Test. The purpose of this test is to verify that the surge protector can be used continuously at a specified maximum voltage, frequency, and temperature without undesirable signal distortion, undesirable power loss, or failure.

7.1.1 The surge protector shall be tested under one or any combination of the following conditions, using test circuits functionally equivalent to those shown in Fig 2:

- (1) At specified voltage, e , and frequency. The voltage shall be stated as rms, ac peak, or dc.
- (2) At specified maximum and minimum ambient temperatures. The protector with voltage applied shall be allowed to stabilize for 24 h at the ambient temperatures before the measurements are made.
- (3) Unless otherwise specified, no load shall be connected to the protector terminals.

7.1.2 Observe the amplitudes and wave-shapes of voltage V_1 and voltage V_2 . Measure the current by means of a suitable ammeter (A) or by a current shunt and an oscilloscope. When making voltage measurements, the ammeters shall be removed from the circuit. When making current measurements, the voltage-measuring instruments shall be removed from the circuit.

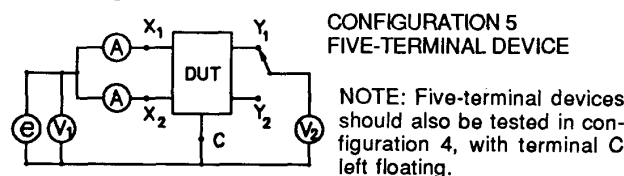
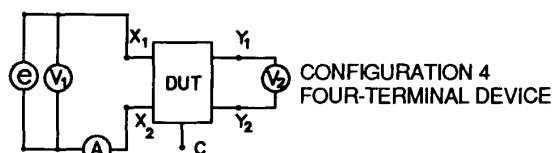
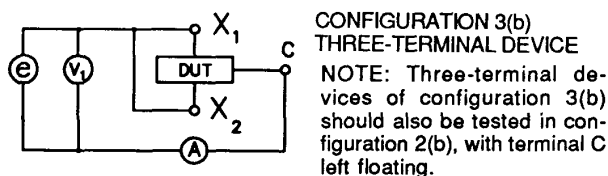
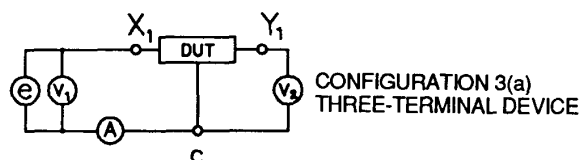
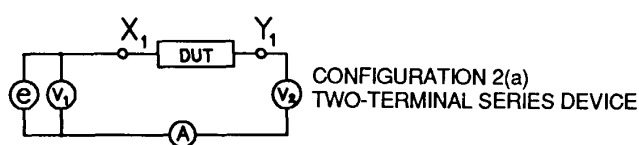
7.1.3 After the temperature stabilization period, the surge protector shall not exhibit specified failure modes (see Section 9) and shall meet the following criteria:

- (1) The protector shall not limit nor distort voltages V_1 or V_2 beyond a specified amount.
- (2) The current (A) shall not exceed a specified value at the ambient temperature of the test. (This current may be referred to as leakage current.)

7.2 Rated Current Test. This test is conducted to verify that a surge protector does not degrade normal circuit functions while carrying the rated current.

7.2.1 The surge protector is to be tested under the following conditions, using the appropriate test circuit as shown in Fig 3:

Fig 2
Test Circuits for the Rated Voltage Test
(Configurations refer to Section 5)



A	=	Ammeter
C	=	Common terminal
DUT	=	Device Under Test
e	=	Source voltage
V ₁ , V ₂	=	Suitable voltage-measuring instruments, e.g., oscilloscopes
X ₁ , X ₂ , Y ₁ , Y ₂	=	Signal terminals

- (1) At rated frequency, dc or as specified.
- (2) Maximum ambient temperature of the application, or as specified.
- (3) A continuous current (I), specified by its dc, ac rms, or ac peak value (+5%, -0%), is to be adjusted by means of the source resistance (R_s) with the protector in the circuit.
- (4) The test shall be conducted until temperature stabilization of the protector occurs.
- (5) The voltages e , e_1 , and e_2 shall be the rated voltage(s). Normally $e_1 = e_2$, except where opposite polarity is an important requirement.
- (6) R_L shall approximate the load resistance of the intended application.
- (7) For ungrounded circuit applications, the circuits in (a), (c), or (d) of Fig 3 shall be used.

- (8) For multi-circuit devices, as many circuits as are expected to be active at the same time shall be simultaneously exposed to the rated current.

7.2.2 At the conclusion of the test, the surge protector shall not experience a failure mode relevant to the application (see Section 9). The voltage across R_L shall not have more than a specified increase in total harmonic distortion as compared to the value measured with the protector replaced by a short circuit. In the absence of specified requirements, the increase shall not exceed 1%.

7.3 DC Series Resistance Test. This test is conducted to determine the dc series resistance between specified terminals of a surge protector.