

IEEE Standard for Performance Criteria and Test Methods for Plug-in (Portable) Multiservice (Multiport) Surge- Protective Devices for Equipment Connected to a 120 V/240 V Single Phase Power Service and Metallic Conductive Communication Line(s)

IEEE Power & Energy Society

Sponsored by the
Surge Protective Devices Committee

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

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IEEE Standard for Performance Criteria and Test Methods for Plug-in (Portable) Multiservice (Multiport) Surge- Protective Devices for Equipment Connected to a 120 V/240 V Single Phase Power Service and Metallic Conductive Communication Line(s)

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Abstract: Test methods and performance criteria for plug-in (portable) multiservice (multiport) surge protective devices (MSPDs) intended to protect equipment connected to one or more metallic conductive telecommunication line(s) and a 120 V/240 V single phase two-wire (line and neutral) ac power service, with the neutral grounded at the service equipment are defined in this standard. Performance testing covers three areas: the ac power SPD section, the telecommunication SPD section, and the MSPD as whole. Essential MSPD performance characteristics are the reduction of surge current in the equipment ground loops and surge coupling between the individual SPD sections.

Keywords: available fault current interrupting capacity, disconnect, ground surge current reduction ratio, IEEE C62.50, MSPD, multiservice (multiport) surge protector, surge reference equalizer

The Institute of Electrical and Electronics Engineers, Inc.
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Participants

At the time this IEEE standard was completed, the Surge Protection of Equipment Connected to AC Power and Communications Circuits Working Group had the following membership:

Antony John Surtees, *Chair*
Ronald W. Hotchkiss, *Secretary*
Michael Maytum, *Vice Chair and Technical Editor*
Kenneth Brown, Charles Jensen, Michael Maytum, *Task Force Leaders*

Robert Ashton
William Bush

Richard Cohen
Douglas Dorr
Albert Martin

Francois Martzloff
Dean Negrelli

The following individuals and interested parties also participated in assisting the working group in the development of this standard.

Bryan Cole
Tom Conrad
Joseph DeGregoria
Leonard Drewes
James Funke
Bill Goldbach

Phillip Havens
Joseph L. Koepfinger
Carl Lindquist
James Moellmann
Carey Mossop
Wolfgang Oertel

Alan Rebeck
Rick Syverson
Jim Tiesi
Bill Travis
Frank Waterer
Don Worden

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

William Ackerman
Robert Ashton
Gustavo Brunello
William Bush
Mark Bushnell
William Byrd
Carlo Donati
Gary Donner
Douglas Dorr
Gary Engmann
Dan Evans
James Funke
David Gilmer
Randall Groves
Gary Heuston
Raymond Hill
Ronald W. Hotchkiss

C. Huntley
Charles Jensen
Yuri Khersonsky
Morteza Khodaie
Chad Kiger
Joseph L. Koepfinger
Jim Kulchisky
Saumen Kundu
Chung-Yiu Lam
Benjamin Lanz
Greg Luri
Albert Martin
Michael Maytum
William McBride
Jerry Murphy
Arthur Neubauer
Michael S. Newman
Gary Nissen

Wolfgang Oertel
Lorraine Padden
Donald Parker
Thomas Phipps
Percy Pool
Iulian Profir
Michael Roberts
Thomas Rozek
Bartien Sayogo
Gil Shultz
James Smith
Jerry Smith
Gary Stoedter
Donald Turner
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James Wilson
Jian Yu

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Julie Alessi
IEEE Standards Program Manager, Document Development

Malia Zaman
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Introduction

This introduction is not part of IEEE Std C62.50-2012, IEEE Standard for Performance Criteria and Test Methods for Plug-in (Portable) Multiservice (Multiport) Surge-Protective Devices for Equipment Connected to a 120 V/240 V Single Phase Power Service and Metallic Conductive Communication Line(s).

The conventional practice of applying surge protective devices (SPDs) at the building entry point of an ac power or telecommunications service has proved inadequate to protect sensitive equipment clusters such as computer workstations and multimedia centers. Surges on the services that feed the protected equipment can be caused by machinery power switching and direct or close-by lightning discharges. Service lightning stroke surges can arise from direct or induced coupling to external services, induction into the building cables, SPD current diversion into the grounding system, and differences in grounding electrode potential. A multiservice SPD supplements the existing protection by providing local protection to the equipment cluster. Services are routed through the multiservice SPD, which protects the services at the cluster to a common reference point and mitigates circulating surge currents in the cluster ground interconnections.

The main content of this standard was developed by three groups of engineers. One group defined the ac service protection requirements, and a second group defined the telecommunication services protection requirements. The third group covered multiservice SPD cross-coupling and defined verification tests for the common ground bonding between the services.

Previously, the technical committee had published a more general guide called *How to Protect Your House and Its Contents from Lightning*—IEEE Guide for Surge Protection of Equipment Connected to AC Power and Communication Circuits (ISBN 0-7381-4634-X). The guide contains useful information about the proper specification and application of surge protectors to protect houses and their contents from lightning and other electrical surges.

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1. Overview

1.1 Scope

The scope of this standard is to define performance criteria and test methods for plug-in (portable) multiservice (multiport) surge protective devices (MSPDs) intended to protect equipment connected to one or more metallic conductive communication line(s) and a 120 V/240 V single phase ac power service, with the neutral grounded at the service equipment. These devices are intended for installation at receptacles supplying power via a branch circuit of the installation, and jointly at receptacles or jacks delivering signals from communications services, for the purpose of providing protected power and signals to a variety of information technology equipment.

1.2 Purpose

The purpose of this project is to provide a uniform specification/test document for design and application engineers, specifiers, and test laboratories to use in designing and testing this type of surge protective device.

1.3 Contents and context

This standard is divided into eight clauses. Clause 1 provides the scope and purpose of this standard. Clause 2 lists references to other standards that are useful in applying this standard. Clause 3 provides definitions that are either not found in other standards, or have been modified for use with this standard. Clause 4 specifies the device markings. Clause 5 describes in general terms the surge environment in which the protectors are expected to perform their protective function, and the rationales for the tests. Clause 6 provides specific test procedures for the power port functions. Clause 7 provides specific test procedures for the communications port functions. Clause 8 provides specific test procedures for the assessment of the protected-side inter-service and ground loop surge coupling performance.

This standard also contains two informative annexes. Annex A provides an overview related to the reasons $I_{\max}$ will remain a declared value. Annex B, the bibliography, provides a list of citations.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ANSI/UL 1449-2006, Surge-Protective Devices.¹

IEEE Std C62.41.2™-2002, Recommended Practice for Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.^{2, 3}

IEEE Std C62.45™-2002, Recommended Practice for Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.

IEEE Std C62.62™-2010, Standard Test Specifications for Surge-Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1000 V and Less) AC Power Circuits.

UL 60950-1 Ed 2-2007, Information Technology Equipment—Safety—Part 1: General Requirements.⁴

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⁴ UL standards are available from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (<http://www.global.ihs.com/>).

3. Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.⁵

available interrupting capacity (AIC): The highest rms current at the rated nominal system voltage of the multiservice surge protective device (MSPD) that the MSPD disconnecter is capable of interrupting under specified circuit power factor conditions.

disconnecter (power SPD): Device for disconnecting a surge protective device (SPD), or part of an SPD, from the power system in the event of SPD failure. (adapted from IEC 61643-11:2010 Ed 1.0)

NOTE 1—The disconnecting device is not required to have isolating capability for safety purposes. It is intended to prevent a persistent fault on the system and may give visible indication of the SPD failure.⁶

NOTE 2—Disconnectors can be internal (built in) or external (required by the manufacturer).

NOTE 3—There may be more than one disconnecter function, for example an over-current protection function and a thermal protection function. These functions may be in separate units.

ground surge current reduction ratio: Quotient of the peak surge current in a service or reference ground by the peak surge current in a ground loop formed by equipment connection and interconnection.

maximum continuous operating voltage (MCOV): The maximum designated root-mean-square (rms) value of the power frequency voltage that may be continuously applied to the mode of protection of a surge protective device (SPD).

measured limiting voltage (MLV): The maximum magnitude of voltage, measured at the leads, terminals, receptacle contacts, and similar locations during the application of an impulse of specified waveshape and amplitude.

modes of protection: Electrical paths where the SPD offers defense against transient overvoltages.

NOTE 1—For a single phase ac power SPD connecting to line, neutral, and ground conductors, the modes of protection can be line-to-neutral (L-N), line-to-ground (L-G) and neutral-to-ground (N-G).

NOTE 2—For poly-phase ac power SPDs connecting to line, neutral, and ground conductors, the modes of protection can be line-to-neutral (L-N), line-to-ground (L-G), line-to-line (L-L), and neutral-to-ground (N-G).

multiservice (multiport) surge protective device (MSPD): A surge protective device providing protection of equipment connected to two or more services such as power, telecommunications, signaling, data, etc., with the respective conductors routed via a common enclosure in which an internal shared ground reference bond has been provided among these services during surge conditions.

NOTE—This standard considers one service will be ac power.

nominal discharge current (I_n): Peak value of the current, selected by the manufacturer, through the SPD having a current waveshape of 8/20 where the SPD remains functional after 15 surges.

power line communication (PLC): Telecommunication using existing power line conductors.

NOTE—Numerous other term synonyms and acronyms exist for PLC, such as broadband over power line carrier (BPL).

⁵ *IEEE Standards Dictionary Online* subscription is available at:

http://www.ieee.org/portal/innovate/products/standard/standards_dictionary.html.

⁶ Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

short-circuit current rating (SCCR) of an SPD: The level at which an SPD is suitable for use on an ac power circuit that is capable of delivering not more than the declared rms symmetrical current at a declared voltage during a short-circuit condition. (adapted from IEEE Std C62.72)

surge reference equalizer: Device used for connecting equipment to external systems whereby all conductors connected to the protected load are routed, physically and electrically, through a single enclosure with a shared reference point between the input and output ports of each system. (adapted from IEC 62066)

NOTE—Sharing the reference point may be accomplished within the device either by a direct bond or through a suitable device, such as an SPD which maintains isolation during normal conditions but provides an effective bond during the occurrence of a surge in one or both systems.

voltage protection rating (VPR): A maximum value of limiting voltage selected from a list of preferred values and assigned to each mode of protection.

NOTE—The VPR is the nearest, highest preferred value to the measured limiting voltage determined when subjecting the power SPD portion of an MSPD to an impulse from a 6 kV, 3 kA combination wave generator.

4. Markings

- Manufacturer's name or trademark and model number
- Maximum continuous operation voltage (MCOV)
- Voltage protection rating (VPR) (one value for each mode of protection)
- Type of current: ac and/or frequency
- Maximum recommended rating and characteristics for external disconnectors, if required
- Rated load current
- Rated nominal system voltage

NOTE—Where space is limited, the manufacturer's name or trademark and model number is sufficient on the MSPD; other remaining required markings shall appear on the smallest package.

5. Surge environment and rationale for tests

The surge environment in which the MSPD is intended to perform its protective function has been characterized in IEEE Std C62.41.2TM-2002⁷ for the power system port and in IEEE Std C62.37TM [B4]⁸ for the different types of communications systems of interest. These standards describe the surges that can impinge on the separate ports of these systems but do not consider the interaction which can occur between the different class of ports (e.g., the power port and the data/communications port). Experience as well as laboratory experiments have demonstrated that during surge conditions, the intended diversion of surge current via surge protective components and their grounding conductors can induce damaging voltages in the loops formed by signaling carrying conductors. In addition, the flow of such diverted current from a power port, for example, can create a potential shift on the ground potential equalization bond between the power port and data port. Limited data are available on the actual parameters of this potential shift, and no standards have been developed to quantify the resulting threat to IT equipment—for which the inter-port withstand characteristic is generally undefined.

⁷ Information on references can be found in Clause 2.

⁸ The numbers in brackets correspond to those of the bibliography in Annex C.

In contrast to the lack of data describing the interaction of one class of port on another, there is an abundance of data describing the operation and failure modes of each of these classes of ports (power, data) in isolation. This standard attempts to specify a limited number of tests that characterizes the basic protection performance of each class of port and refer to those other standards for a more comprehensive treatise when necessary. The following three clauses detail the basic test procedures used to characterize the power port, the communications port(s), and the interaction between them.

Figure 1 below depicts a typical MSPD with individual protection ports for power and data as well as the equipotential bond formed between these.

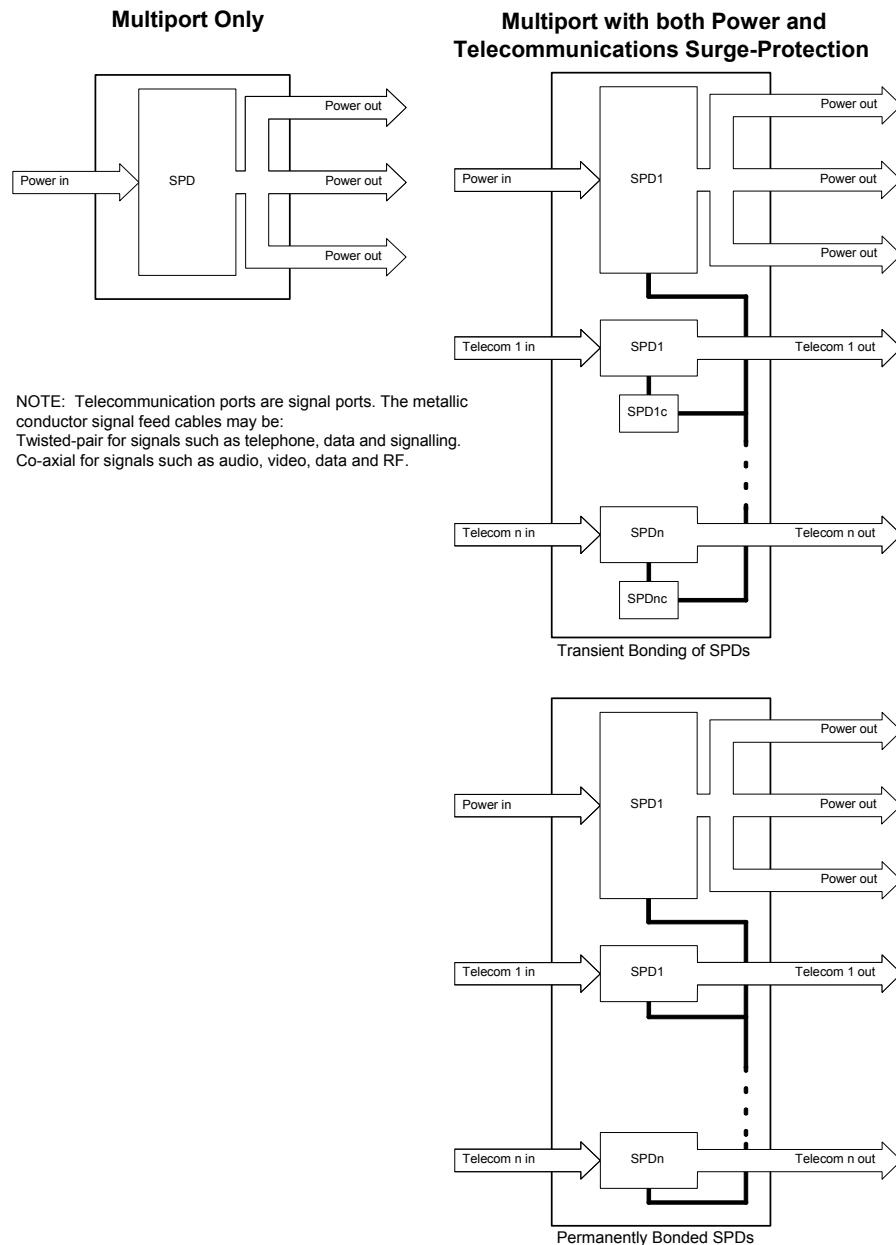


Figure 1—Typical block diagrams of multiservice SPDs showing individual protection ports and the equipotential bonding between them

6. Test procedures for MSPD ac power port

6.1 General considerations

The test procedures described in this clause are derived from recognized test specifications for surge protective devices connected to low-voltage power distribution systems, in particular IEEE Std C62.62™ - 2010 and ANSI/UL 1449-2006. Compatibility and harmonization of these standards are sought in preparing the tests to be performed on the power port; however, for the convenience of the reader and a uniform presentation style, the procedures are described in terms that might be slightly different from the exact words of these two standards, but the rationale and intent are similar, if not identical.

The prospective current from the ac power receptacle supplying the MSPD power port will, to some extent, be dependent on the distance of the receptacle from the from electrical service panel. Two receptacle locations are standardized for this document:

- unrestricted location, where the ac power receptacle may be a negligible wiring distance away from the electrical service panel⁹
- restricted location, where the ac power receptacle is 10 m (30 ft) or more from the electrical service panel¹⁰

6.2 Initial characterization

6.2.1 Rationale

To perform meaningful tests and to evaluate the effects (if any) of the stresses applied to the ac power input port during the test program, it is necessary to determine the basic generic design of the device and establish a minimum baseline characteristic (see Annex B). The information listed below shall be obtained from the manufacturer and confirmed, as appropriate, by inspection or by test. Knowledge of the internal configuration of the MSPD is required in cases where numerical simulation of the device's performance will expand the value of the tests.

6.2.2 Purpose

An initial characterization test is a necessary element of the test program, serving to confirm the surge mitigation performance characteristics declared by the manufacturer, and to provide a baseline for comparison of the post-test condition of the device.

6.2.3 Data required for tests

Prior to conducting any tests, the manufacturer shall provide the following information:

- Circuit diagram of the MSPD: The test laboratory shall receive from the manufacturer a basic block diagram of the MSPD so that the components which may interfere with baseline tests can be disconnected. If disconnection is difficult to perform by the laboratory (e.g., when the MSPD is potted or a circuit board is very crowded), the manufacturer shall provide test specimens with accessible means of disconnecting. An example of this situation is the case of condition-indicating

⁹ The test levels and procedures used correspond to an ANSI/UL 1449-2006 Type 2 – Permanently connected SPD.

¹⁰ The test levels and procedures used correspond to an ANSI/UL 1449-2006 Type 3 – Point of utilization SPD.

lamps that prevent measurement of the reference voltage by itself. Surge-diverting components shall be at least generically identified as spark gap, metal oxide varistor (MOV), solid state, etc., as appropriate.

- Basic principle of operation: This information is necessary to select a meaningful test program, to allow correct interpretation of the test results, and to make early detection of anomalies in performance as the test sequence progresses.
- Ratings: The following MSPD ratings shall be provided by the manufacturer.
 - Maximum continuous operating voltage (MCOV)
 - Voltage protection rating (VPR)
 - Continuous load current (I_L)
 - Nominal discharge current (I_n)
 - Short-circuit current rating (SCCR)

6.2.4 Determination of baseline parameters

The measured limiting voltage of a candidate MSPD ac power port at a moderate surge stress level is the simplest criterion of performance and can also serve as a diagnostic tool for analyzing later changes in the performance. Such a test might also reveal unexpected behavior or side effects.

Comparing the measured limiting voltage of the ac power port with the 100 kHz ring wave before and after some stressful test might be difficult for a multi-component ac power port, in particular one that includes capacitors or multiple varistors connected in parallel. The response of the ac power port to the fast front and subsequent oscillations could mask subtle changes in the behavior of the port nonlinear component. In such a case, a moderate combination wave generator test might yield more meaningful information and provide a better assessment of the condition of the port component than a ring wave generator. From this discussion, it is clear that knowledge of the design can help in defining a meaningful characterization test, which shall therefore be viewed as a tool for assessing the status of the MSPD, not as a pass/fail criterion.

6.2.5 Test procedure guidelines

The measured limiting voltage shall be determined with a 0.5 μ s–100 kHz ring wave, applied in succession across all possible pairs of conductors, with an open-circuit voltage of 1000 V and a generator effective impedance of 30 Ω . This test applies a sufficiently low stress on the device to alleviate concerns about cumulative stresses. If at any time during the test program some question would arise on the condition of the test specimen, this measurement may be repeated in order to gain some insight on a change in the condition of the specimen.

6.2.6 Test set-up requirements

Figure 2 shows a generic diagram of the components necessary to apply the surge and record the results. The surge is applied at the MSPD ac power service input port, and the limiting voltage is measured at a selected MSPD ac power outlet port. For this test, the surge generator is delivering the ring wave.

6.2.7 Expected results

Measured limiting voltage is the maximum magnitude of voltage, measured at the leads, terminals, receptacle contacts, and similar locations during the application of an impulse of specified waveshape and amplitude. The oscillograms recorded during this test shall be kept as part of the report and defined as