IEC 61557-16

Edition 2.0 2023-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures –
Part 16: Equipment for testing the effectiveness of the protective measures of electrical equipment and/or medical electrical equipment

Sécurité électrique dans les réseaux de distribution basse tension au plus égale à 1 000 V en courant alternatif et 1 500 V en courant continu – Dispositifs de contrôle, de mesure ou de surveillance de mesures de protection –
Partie 16: Équipement pour les essais de bon fonctionnement des mesures de protection des appareils électriques et/ou des appareils électromédicaux

IEC 61557-16:2023-08(en-fr)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, …). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

IEC 61557-16

Edition 2.0 2023-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures –
Part 16: Equipment for testing the effectiveness of the protective measures of electrical equipment and/or medical electrical equipment

Sécurité électrique dans les réseaux de distribution basse tension au plus égale à 1 000 V en courant alternatif et 1 500 V en courant continu – Dispositifs de contrôle, de mesure ou de surveillance de mesures de protection –
Partie 16: Équipement pour les essais de bon fonctionnement des mesures de protection des appareils électriques et/ou des appareils électromédicaux

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 17.220.20, 29.080.01

ISBN 978-2-8322-7251-0

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ELECTRICAL SAFETY IN LOW VOLTAGE DISTRIBUTION SYSTEMS UP TO 1 000 V AC AND 1 500 V DC – EQUIPMENT FOR TESTING, MEASURING OR MONITORING OF PROTECTIVE MEASURES –

Part 16: Equipment for testing the effectiveness of the protective measures of electrical equipment and/or medical electrical equipment

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 61557-16 has been prepared by IEC technical committee 85: Measuring equipment for electrical and electromagnetic quantities. It is an International Standard.

This second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) splitting of uncertainty requirements for medical and non-medical electrical equipment in 4.2.1;
b) addition of a definition of ranges with defined uncertainty in 4.2.1 to 4.2.7;
c) addition of an optional measuring device (MD) for non-medical devices in 4.2.1;

d) addition of a limitation of the maximum intrinsic uncertainty for medical applications at leakage current in 4.2.1;

e) change of 4.2.3 from test sockets to sockets for service purposes;

f) addition of a warning in the operating instructions;

g) integration of former 6.3 into 6.2;

h) update of Table 1;

i) alignment of the structure with that of the whole IEC 61557 series.

The text of this International Standard is based on the following documents:

Draft	Report on voting
85/876/FDIS	85/885/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

This International Standard is to be used in conjunction with IEC 61557-1:2019.

A list of all parts in the IEC 61557 series, published under the general title *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This part of IEC 61557 defines performance requirements of measuring equipment intended for testing the effectiveness of the protective measures of either electrical equipment or medical electrical equipment, or both (in accordance with IEC 62353). It is the intention of this document to achieve comparable measuring results, additional safety for the person carrying out the testing, and non-damaging electrical stress for the unit under test.

ELECTRICAL SAFETY IN LOW VOLTAGE DISTRIBUTION SYSTEMS UP TO 1 000 V AC AND 1 500 V DC – EQUIPMENT FOR TESTING, MEASURING OR MONITORING OF PROTECTIVE MEASURES –

Part 16: Equipment for testing the effectiveness of the protective measures of electrical equipment and/or medical electrical equipment

1 Scope

This part of IEC 61557 specifies the requirements applicable to the performance for test and measurement equipment in order to determine the effectiveness of the protective measures for electrical equipment and/or medical electrical equipment described in IEC 62353.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60601-1:2005, *Medical electrical equipment – Part 1: General requirements for basic safety and essential performance*
IEC 60601-1:2005/AMD1:2012
IEC 60601-1:2005/AMD2:2020

IEC 61010-1:2010, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*
IEC 61010-1:2010/AMD1:2016

IEC 61010-031, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 031: Safety requirements for hand-held and hand-manipulated probe assemblies for electrical test and measurement*

IEC 61010-2-030, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for equipment having testing or measuring circuits*

IEC 61010-2-032, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 2-032: Particular requirements for hand-held and hand-manipulated current sensors for electrical test and measurement*

IEC 61010-2-034, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-034: Particular requirements for measurement equipment for insulation resistance and test equipment for electric strength*

IEC 61557-1:2019, *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures – Part 1: General requirements*

IEC 61557-2, *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures – Part 2: Insulation resistance*

IEC 61557-4, *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures – Part 4: Resistance of earth connection and equipotential bonding*

IEC 61557-10, *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures – Part 10: Combined measuring equipment for testing, measuring or monitoring of protective measures*

IEC 61557-13, *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures – Part 13: Hand-held and hand-manipulated current clamps and sensors for measurement of leakage currents in electrical distribution systems*

IEC 62353:2014, *Medical electrical equipment – Recurrent test and test after repair of medical electrical equipment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61557-1, IEC 61557-2, IEC 61557-4, IEC 61557-10 and IEC 61557-13, and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
test socket outlet
socket outlet on the test equipment that can be switched to either test-condition or supply condition

3.2
service socket
socket outlet on the test equipment to supply mains to further test equipment or additional equipment

3.3
measuring circuit MD
electric circuit with defined components and defined frequency characteristic

3.4
peak factor
ratio of the maximum absolute value of an alternating quantity to its RMS value

[SOURCE: IEC 60050-103:2017, 103-06-15, modified – Note to entry omitted.]

3.5
medical electrical equipment
ME equipment
electrical equipment having an applied part or transferring energy to or from the patient or detecting such energy transfer to or from the patient and which is:

a) provided with not more than one connection to a particular supply mains, and

b) intended by its manufacturer to be used:

   – in the diagnosis, treatment, or monitoring of a patient, or

   – for compensation or alleviation of disease, injury or disability

Note 1 to entry: ME equipment includes those accessories as defined by the manufacturer that are necessary to enable the normal use of the ME equipment.

Note 2 to entry: Not all electrical equipment used in medical practice falls within this definition (e.g. some in vitro diagnostic equipment).

Note 3 to entry: The implantable parts of active implantable medical devices can fall within this definition, but they are excluded from the scope of IEC 60601-1 by appropriate wording in IEC 60601-1:2005, Clause 1, IEC 60601-1:2005/AMD1:2012, Clause 1, and IEC 60601-1:2005/AMD2:2020, Clause 1.

[SOURCE: IEC 60601-1:2005, 3.63, modified – Notes 4 and 5 deleted.]

3.6
protective earth resistance
resistance between any accessible conductive part which has to be connected for safety purposes to the protective earth terminal and the

– protective connector of the mains plug, or

– protective connector of the appliance inlet, or

– protective conductor permanently connected to the supply mains;

resistance between protective connectors at each end of a detachable power supply cord

[SOURCE: IEC 62353:2014, 3.34]

4 Requirements

4.1 General requirements

In addition to the requirements of IEC 61557-1:2019, Clause 4, the following requirements shall apply.

The requirements of IEC 62353:2014, Annex C shall apply for measuring equipment intended for medical electrical equipment testing.

Equipment intended for making measurements on electrical equipment shall be rated for minimum measurement category II in accordance with IEC 61010-2-030.

Insulation measurement equipment shall fulfil the safety requirements of IEC 61010-2-034.

Test leads and test probes used with the measuring equipment shall fulfil the requirements of IEC 61010-031.

4.2 Measuring functions

4.2.1 Minimum measuring function requirements

The measuring equipment shall be capable of measuring the following quantities as a minimum:

– resistance of protective bonding and/or protective earth resistance,

– insulation resistance,

– protective conductor current and/or equipment leakage current,

– touch current,

– applied part leakage current for measuring equipment intended for medical electrical equipment testing (IEC 62353).

The operating uncertainty for all measured parameters within the required ranges at the applicable limits according to IEC 62353 shall be ±15 % at the maximum. For measurement of protective conductor current, equipment leakage current, touch current and applied part leakage current the operating uncertainty shall be determined at a frequency of 50/60 Hz. The frequency characteristic for higher frequency ranges is given by the MD circuit according to Figure A.1 and Figure A.2.

Leakage currents for medical electrical equipment shall be measured using a measuring circuit MD with the characteristics defined in Clause A.1 and Clause A.2. Leakage currents for non-medical electrical equipment may be tested using a measuring circuit MD in accordance with IEC 61010-1:2010, Clause A.1.

For medical electrical equipment, the maximum intrinsic uncertainty for leakage current measurements shall be ±5 %.

NOTE If the measuring equipment evaluates a limit, for example 3,5 mA, the maximum applicable uncertainty can be taken into account, for example ± 15 %. This means that only measurements less than or equal to 2,97 mA can pass the test.

The operating uncertainty shall be determined in accordance with IEC 61557-1 with the influence quantities E_1, E_2, E_3, E_9 modified, E_{11}, E_{12}, and, if applicable, E_{13}, E_{14}, E_{15} in accordance with IEC 61557-13.

4.2.2 Measurement of the resistance of the protective bonding or the protective earth resistance

The measuring equipment shall be in accordance with IEC 61557-4. The withstand capability against extraneous voltages is not required if the test and measurement equipment is not intended to be used on fixed installed or permanently connected equipment.

To prevent damage to the equipment under test it is recommended to select a test current not exceeding 1 A.

The measuring circuit shall be separated from the active parts of mains by double or reinforced insulation in accordance with IEC 61010-1. The protective conductor may be connected to the measuring circuit, but parallel earth connections shall be indicated and/or taken into account by the test and measurement equipment.

When external resistances are included in the calibration as a zero offset, this shall be indicated. The indication shall continue as long as the calibration is valid.

The measuring range shall include the values between 0,05 Ω and 1,99 Ω and the display shall have a minimum resolution of 0,01 Ω. Within the range of 0,1 Ω and 1,99 Ω, the measuring current shall not be less than 0,2 A and the operating uncertainty shall be within the limits of 4.2.1.

Continuous measurements shall be possible for measuring currents below 5 A. For higher test currents, limiting the test duration is allowed.

4.2.3 Measurement of insulation resistance

The measuring equipment shall be in accordance with IEC 61557-2. The withstand capability against extraneous voltages is not required if the test and measurement equipment is not intended to test fixed installed or permanently connected equipment.

The measuring range shall include the values between 100 kΩ and 100 MΩ and the display shall have a minimum resolution of 0,1 MΩ. The operating uncertainty shall be within the limits of 4.2.1. If the test and measurement equipment is not intended to test applied parts type F in accordance with IEC 62353, the measuring range can be limited to 10 MΩ.

The measuring circuit shall be separated from the active parts of mains by double or reinforced insulation in accordance with IEC 61010-1. The protective conductor may be connected to the measuring circuit.

4.2.4 Measurement of protective conductor current or equipment leakage current with the alternative method

The alternative method shows values of the leakage current calculated using the test voltage generated by the measuring equipment.

If the test and measurement equipment include the alternative method, the requirements for the measuring circuit (in the following dashed list) shall apply:

– sinusoidal test voltage at mains frequency, total harmonic distortion (THD) shall not exceed 5 %;
– open circuit test voltage between 25 V and 250 V. If test and measurement equipment is specified in accordance with IEC 62353 the test voltage shall be equal to the nominal mains supply voltage;
– minimum resolution 0,01 mA;
– measuring resistance of up to 1 kΩ (up to 2 kΩ if it is intended for the testing of non-medical electrical equipment only);
– output current limited to 3,5 mA for test voltages above 50 V;
– scaling of the measured results up to the nominal mains voltage;
– minimum current measuring range between 0,02 mA and 19,99 mA.

If the test and measurement equipment is intended for tests on non-medical electrical equipment only, the lower limit of the measuring range may be increased to 0,2 mA and the resolution decreased to 0,1 mA.

The operating uncertainty or intrinsic uncertainty for the range of 0,02 mA or 0,2 mA up to 19,99 mA shall fulfil the requirements of 4.2.1.

The measuring circuit shall be separated from the active parts of mains by double or reinforced insulation in accordance with IEC 61010-1. The protective conductor may be connected to the measuring circuit.

4.2.5 Measurement of touch current, patient leakage current and applied part leakage current with the alternative method

If the test and measurement equipment include the alternative method, the requirements for the measuring circuit in the following dashed list shall apply:

– sinusoidal test voltage at mains frequency,
– open circuit test voltage between 25 V and 250 V. If test and measurement equipment is specified in accordance with IEC 62353 the test voltage shall be equal to the nominal mains supply voltage,
– minimum resolution 0,001 mA,
– measuring resistance of up to 1 kΩ (up to 2 kΩ if it is intended for the testing of non-medical electrical equipment only),
– output current limitation to 3,5 mA for test voltages above 50 V,
– scaling of the measured results up to the nominal mains voltage,
– scaled minimum current measuring range between 0,02 mA and 19,99 mA.