# IEC 61557-16

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# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

## Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – 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 de 1 000 V c.a. et 1 500 V c.c. – 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 de l'équipement électrique et/ou de l'équipement médical électrique

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# ELECTRICAL SAFETY IN LOW VOLTAGE DISTRIBUTION SYSTEMS UP TO 1 000 V A.C. AND 1 500 V D.C. – 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

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The text of this standard is based on the following documents:

| FDIS | Report on voting |
|---|---|
| 85/487/FDIS | 85/504/RVD |

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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This part of IEC 61557 shall be used in conjunction with Part 1.

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 a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures,* can be found on the IEC website.

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# INTRODUCTION

This part of IEC 61557 defines performance requirements for measuring equipment using measuring methods described in IEC 62353, especially for evaluation of leakage currents within electrical equipment. It is the intention of this standard to achieve comparable measuring results, additional safety for the testing person and negligible electrical stress for the unit under test.

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## 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 defines performance requirements for test and measurement equipment to determine the effectiveness of the protective measures of electrical measures for electrical equipment and/or medical electrical equipment described in IEC 62353.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 61000-4-8, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

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

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

IEC 61010-2-030, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for testing and 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 61326-1, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

IEC 61326-2-2, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 2-2: Particular requirements – Test configurations, operational conditions and performance criteria for portable test, measuring and monitoring equipment used in low-voltage distribution systems*

IEC 61557-1:2007, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 1: General requirements*

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

IEC 61557-4:2007, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – 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 a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 10: Combined measuring equipment for testing, measuring or monitoring of protective measures*

IEC 61557-13:2011, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – 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, *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 (if applicable) and the following apply.

**3.1**
**test socket outlet**
socket outlet on the test equipment for the unit under test, separated from the active parts of the mains circuit by double insulation

**3.2**
**mains socket outlet**
socket outlet on the test equipment used to supply mains to the equipment under test

**3.3**
**combined test-mains socket outlet**
socket outlet on the test equipment that can be switched to either test-condition and/or supply condition

**3.4**
**service socket**
socket outlet on the test equipment to supply mains to further test equipment or additional equipment

**3.5**
**test terminal**
terminal used independently, in parallel or in combination, with the test socket

**3.6**
**measuring circuit MD**
electric circuit with defined components and defined frequency characteristic

**3.7**
**peak factor**
ratio of the maximum absolute value of an alternating quantity to its root-mean-square value

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[SOURCE: IEC 60050-103:2009, 103-06-15]

# 4 Requirements

## 4.1 Measurement requirements for measuring equipment

### 4.1.1 General

The measuring equipment shall be capable of measuring at least the following quantities:

– resistance of protective bonding and/or protective earth resistance,
– insulation resistance,
– protective conductor current and/or equipment leakage current,
– touch current and/or applied part leakage current.

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. This requirement shall be fulfilled for the measurement of leakage currents within a frequency range given by the frequency characteristic of the measuring circuit MD.

If external current clamps are connected to the test and measurement equipment, they shall comply with the requirements of IEC 61557-13 and their operating uncertainty shall be included in the operating uncertainty of the measurement. In case of current clamps of class 2 and class 1 and external magnetic fields of 30 A/m and 100 A/m, the overall operating uncertainty may be extended to ± 20 % (class 2 and 30 A/m) or ± 30 % (class 1 and 100 A/m).

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

### 4.1.2 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.

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

In case of calibrated detachable test leads, the calibration shall be indicated and 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 below 0,2 A. The operating uncertainty shall be within the limits of 4.1.

Continuous measurements shall be possible for measuring currents below 5 A. For higher currents a limitation is allowed after a specified time or by temperature control.

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#### 4.1.3 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 operating uncertainty shall be within the limits of 4.1. If the test and measurement equipment is not intended to test applied parts type F according to IEC 62353, the measuring range is limited to 10 MΩ.

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

#### 4.1.4 Measurement of protective conductor current and/or equipment leakage current with the alternative method

If the test and measurement equipment includes the alternative method, the following requirements for the measuring circuit apply:

– sinusoidal test voltage at mains frequency, THD shall not exceed 5 %;
– open circuit test voltage between 25 V and 250 V. If test and measurement equipment is specified according to IEC 62353 the test voltage shall be on the same level as the nominal mains supply voltage;
– current measuring range between 0,02 mA and 19,99 mA at the minimum;
– minimum resolution 0,01 mA;
– current measuring circuit MD;
– output current limitation to 3,5 mA for test voltages above 50 V;
– recalculation of the measuring result up to the nominal supply voltage.

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

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

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

If the test and measurement equipment includes the alternative method, the following requirements for the measuring circuit apply:

– sinusoidal test voltage at mains frequency,
– open circuit test voltage between 25 V and 250 V. If test and measurement equipment is specified according to IEC 62353 the test voltage shall be equal to the nominal mains supply voltage,
– current measuring range between 0,02 mA and 19,99 mA at the minimum,
– minimum resolution 0,001 mA,
– current measuring circuit MD,
– output current limitation to 3,5 mA for test voltages above 50 V,
– recalculation of the measuring result up to the nominal supply voltage.

If the test and measurement equipment is intended only for tests on non-medical equipment, the lower limit of the measuring range may be increased to 0,1 mA and the resolution to 0,01 mA.

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

#### 4.1.6 Measurement of protective conductor current and or equipment leakage current with the direct method or differential method (residual method)

If the test and measurement equipment includes the direct method or differential method the following requirements apply:

– measurement in both polarities of mains supply voltage in case of single phase equipment,
– current measuring range (frequency weighted) between 0,01 mA and 19,99 mA at the minimum,
– current measuring range (non-frequency weighted according to Figure A.2) shall be specified,
– minimum resolution 0,01 mA,
– current measuring circuit MD for the direct method,
– measurement of r.m.s values up to a peak factor 2 at the minimum taking into account the required frequency characteristic see Annex A. In case of differential method the lower limit of frequency range is 40 Hz and the upper limit shall include 100 kHz at the minimum.

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

The test and measurement equipment shall provide additional protective means against electric shock or fire when the units under test are in single fault condition.

In case of automatic test sequences, the unit under test shall not be connected to the supply voltage as long as the applicable limits for resistance of protective bonding and insulation resistance according to IEC 62353 are exceeded.

In case of non-automatic test sequences, the test and measurement equipment shall indicate or display a warning to be aware of connection to the mains supply

If external current clamps are used for measurements, they shall comply with the requirements of IEC 61557-13 and their operating uncertainty shall be included. The lower limit of measuring range may be increased to 1 mA. In case of current clamps of class 2 and class 1 and external magnetic fields of 30 A/m and 100 A/m, the overall operating uncertainty may be extended to 20 % (class 2 and 30A/m) and 30 % (class 1 and 100 A/m). Leakage currents shall be evaluated according to the frequency characteristic beginning at 40 Hz and up to 10 kHz at the minimum and a warning shall be added to the operating instructions in 5.2.

#### 4.1.7 Measurement of touch current, patient leakage current and applied part leakage current with the direct method or differential method (residual method)

If the test and measurement equipment includes the direct method or differential method, the following requirements apply:

– measurement in both polarities of mains supply voltage in case of single phase equipment;
– current measuring range (frequency weighted according to Figure A.2) between 0,01 mA and 1,999 mA at the minimum;
– current measuring range (non-frequency weighted) shall be specified;
– minimum resolution 0,001 mA;
– current measuring circuit MD for the direct method,
– measurement of r.m.s values up to a peak factor of 2 at the minimum taking in account the required frequency characteristic see Annex A. In case of the differential method, the

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