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BSI Standards Publication

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

National foreword

This British Standard is the UK implementation of EN 61557-13:2011. It is identical to IEC 61557-13:2011.

The UK participation in its preparation was entrusted to Technical Committee PEL/85, Measuring equipment for electrical and electromagnetic quantities.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 September 2011.

Amendments/corrigenda issued since publication

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31 January 2013	Correction to BS title

EUROPEAN STANDARD

NORME EUROPÉENNE

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EN 61557-13

September 2011

ICS 17.220.20; 29.080.01; 29.240.01

English version

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 61557-13:2011)

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 13: Pinces et capteurs de courant portatifs et manipulés à la main pour la mesure des courants de fuite dans les réseaux de distribution électriques
(CEI 61557-13:2011)

Elektrische Sicherheit in Niederspannungsnetzen bis AC 1 000 V und DC 1 500 V - Geräte zum Prüfen, Messen oder Überwachen von Schutzmaßnahmen - Teil 13: Handgehaltene und handbediente Strommesszangen und Stromsonden zur Messung von Ableitströmen in elektrischen Anlagen
(IEC 61557-13:2011)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Foreword

The text of document 85/387/FDIS, future edition 1 of IEC 61557-13, prepared by IEC TC 85, "Measuring equipment for electrical and electromagnetic quantities" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61557-13:2011.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-05-12
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2014-08-12

This standard is to be used in conjunction with EN 61557-1:2007.

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Endorsement notice

The text of the International Standard IEC 61557-13:2011 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 60359	NOTE Harmonized as EN 60359.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 61000-4-8	2009	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	EN 61000-4-8	2010
IEC 61010-1	-	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements	EN 61010-1	-
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	EN 61010-2-030	-
IEC 61010-2-032	2002	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	EN 61010-2-032	2002
IEC 61326-1	-	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements	EN 61326-1	-
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	EN 61326-2-2	-
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	EN 61557-1	2007

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

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International Standard IEC 61557-13 has been prepared by IEC technical committee TC85: Measuring equipment for electrical and electromagnetic quantities.

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

FDIS	Report on voting
85/387/FDIS	85/391/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.

This part is to be used in conjunction with IEC 61557-1:2007.

A list of all parts of 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.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

INTRODUCTION

During periodical inspections of electrical installations, it is increasingly difficult to carry out measurements of insulation resistances with devices according to IEC 61557-2 when the installations cannot be switched off for long periods and when there are sensitive appliances connected. Therefore, the measurement of leakage currents can provide additional information about the safe or unsafe situation of an installation.

Furthermore, the user has the opportunity to place current clamps and sensors on different points of the distribution system for troubleshooting nuisance tripping of RCDs, alarms of RCMs and other problems caused by low frequency leakage currents.

Unfortunately, the presence of high external magnetic fields has a big impact on the performance of commonly used current clamps and sensors. High uncertainty and non-repeatability of readings can lead to unsafe interpretations.

This standard defines performance classes for current clamps and sensors in relationship to ranges of high external magnetic fields and gives guidance to the user to choose the appropriate measuring device for a given situation.

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

1 Scope

This part of IEC 61557 defines special performance requirements for hand-held and hand-manipulated current clamps and sensors for measurement of leakage currents in electrical distribution systems up to 1 000 V a.c. and 1 500 V d.c., taking into account the influence of high external low-frequency magnetic fields and other influencing quantities. This standard does not apply to current clamps or sensors which are used in combination with devices for insulation fault location according to IEC 61557-9, unless it is specified by the manufacturer.

2 Normative references

The following referenced documents are indispensable for the application 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 61000-4-8:2009, *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 61010-2-030, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for testing and measuring circuits*

IEC 61010-2-032:2002, *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*

3 Terms and definitions

For the purposes of this document, the definitions given in IEC 61557-1 and the following definitions apply.

3.1
hand-held and hand-manipulated current clamps and sensors
portable or hand-held device for measurement, display or for indication of types of leakage currents in distribution systems without interruption of these circuits including defined attached equipment

NOTE In the following text, only the expression “current sensors” is used.

3.2
fixing device
device to fix the position of a conductor in relation to the current sensors

3.3
measurement category
coordination of maximum transients to the working voltage according to IEC 61010-2-030

3.4
variation E_{11}
variation due to external low frequency magnetic fields

3.5
variation E_{12}
variation due to load current during measurement using the differential method (see Annex A, Figure A.2)

3.6
variation E_{13}
variation due to touch current caused by common mode voltage during hand-manipulation

3.7
variation E_{14}
variation due to frequency

3.8
variation E_{15}
repeatability of the measurement readings due to at least 10 open / close cycles

3.9
operating class
performance class defining the influence of external low frequency magnetic fields on the current sensors (see 4.2)

3.10
leakage current
current driven by active conductors of a distribution system and/or loads to earth and/or protective conductors

[IEC 60050-195:1998, 195-05-15, modified]

3.11
load current
current flowing through the line conductor/s

3.12
rated burden
the value of the burden on which the accuracy requirements of a specification are based

[IEC 60050-321:1986, 321-01-26]

4 Requirements

4.1 General

The following requirements as well as those given in IEC 61557-1 shall apply.

Current sensors according to this standard shall comply with IEC 61010-2-032.

Current sensors according to this standard shall have the ability to measure leakage currents from 1 mA to 10 A a.c. and/or d.c. as a minimum and shall be designed for a load current of at least 60 A. Multiple ranges are allowed.

The resolution shall be 0,1 mA a.c. and/or d.c or better.

The indicated current values shall be r.m.s. values.

The frequency range of the current sensors shall include the range beginning at 40 Hz up to the third harmonic of the rated mains frequency at the minimum.

NOTE 1 For railway applications a frequency range beginning at 15 Hz is recommended.

NOTE 2 For industrial applications a frequency range up to 1 kHz is recommended.

NOTE 3 For testing the leakage current of appliances a measuring range starting at 0,1 mA with a resolution of 0,01 mA is recommended.

4.2 Operating classes

4.2.1 General

According to their sensitivity for low frequency magnetic fields according to IEC 61000-4-8 within the range of 15 Hz up to 400 Hz, current sensors are classified into 3 operating classes.

4.2.2 Operating class 1

Current sensors of operating class 1 shall be applicable to operate within external low frequency magnetic fields according to 4.2.1 up to a field strength of 100 A/m. The upper limit of field strength shall be marked on the pictogram according to 5.1.

4.2.3 Operating class 2

Current sensors of operating class 2 shall be applicable to operate within external low-frequency magnetic fields according to 4.2.1 up to a field strength of 30 A/m. The upper limit of field strength shall be marked on the pictogram according to 5.1.

4.2.4 Operating class 3

Current sensors of operating class 3 shall be applicable to operate within external low frequency magnetic fields according to 4.2.1 up to a field strength of 10 A/m. The upper limit of field strength shall be marked on the pictogram according to 5.1.

4.3 Measuring range / percentage operating uncertainty of reading

4.3.1 General

Percentage operating uncertainty of current sensors of operating class 1, operating class 2 and operating class 3 shall be determined according to the equation of Table 2 within the operating conditions of 4.4. The relation between operating class and external magnetic field is shown in Figure 1, Figure 2 and Table 1.

The fiducial value is the measured value of the leakage current.

4.3.2 Measuring range of an operating class 1 current sensor

The measuring range of an operating class 1 current sensor is the range of indicated values between stated lower and upper measurements for which the percentage operating uncertainty of reading is:

– less than 15 % for values less than or equal to 10 mA, and is less than 10 % for values greater than 10 mA for external low frequency magnetic fields of up to 10 A/m;

and

– less than 20 % for values less than or equal to 10 mA and is less than 12.5 % for values greater than 10 mA for external low frequency magnetic fields of up to 30 A/m;

and

– less than 30 % for values less than or equal to 10 mA, and is less than 15 % for values greater than10 mA for external low frequency magnetic fields of up to 100 A/m.

4.3.3 Measuring range of an operating class 2 current sensor

The measuring range of an operating class 2 current sensor is the range of indicated values between stated lower and upper measurements for which the percentage operating uncertainty of reading is:

– less than 15 % for values less than or equal to 10 mA and is less than 10 % for values greater than10 mA for external low frequency magnetic fields of up to 10 A/m;

and

– less than 20 % for values less than or equal to 10 mA and is less than 12,5 % for values greater than 10 mA for external low frequency magnetic fields of up to 30 A/m.

4.3.4 Measuring range of an operating class 3 current sensor

The measuring range of an operating class 3 instrument is the range of indicated values between stated lower and upper measurements for which the percentage operating uncertainty of reading is:

– less than 15 % for values less than or equal to 10 mA and is less than 10 % for values greater than10 mA for external low frequency magnetic fields of up to 10 A/m.

Table 1 – Relation of external field and operating class

External field strength	10 A/m	30A/m	100A/m
Percentage operating uncertainty of reading ≤10 mA	15%	20%	30%
Percentage operating uncertainty of reading >10 mA	10%	12,5 %	15%
Operating class 1 current sensor	✔	✔	✔
Operating class 2 current sensor	✔	✔	-
Operating class 3 current sensor	✔	-	-

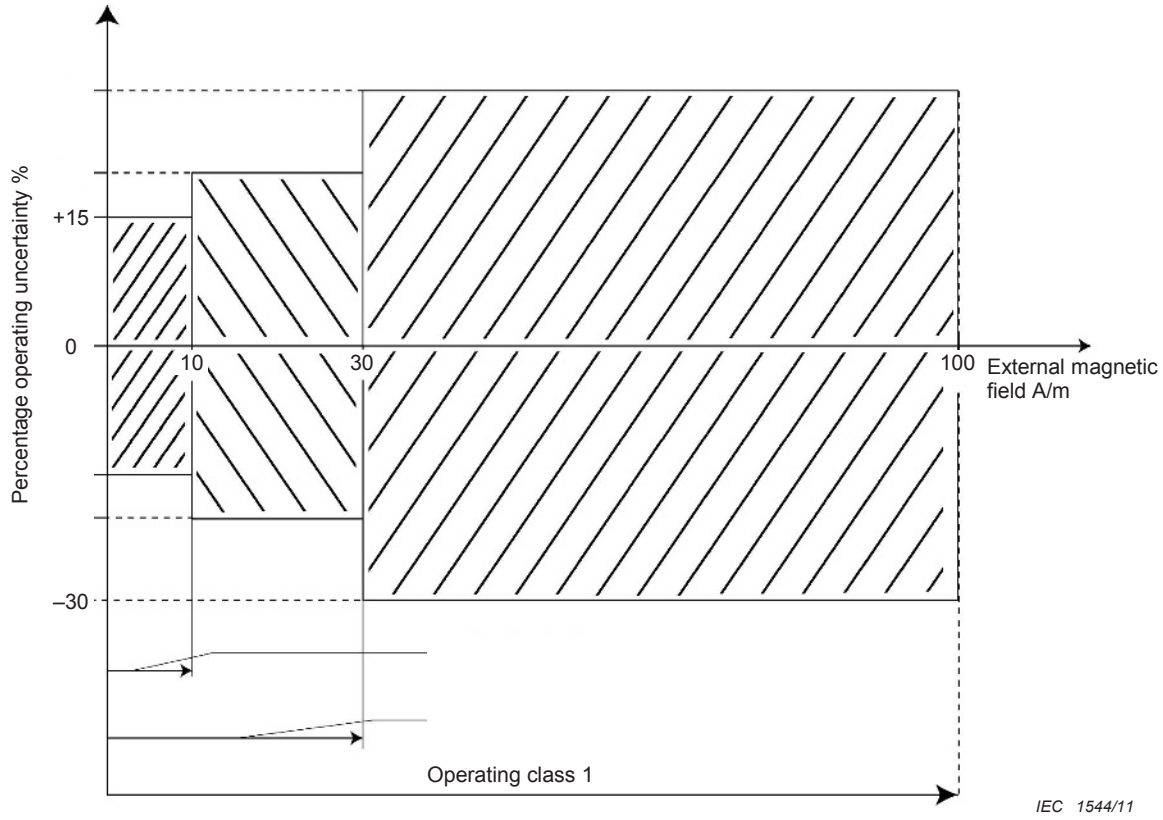

Figure 1 – Percentage operating uncertainty in relation to operating class and external magnetic field for measuring ranges less than or equal to 10 mA

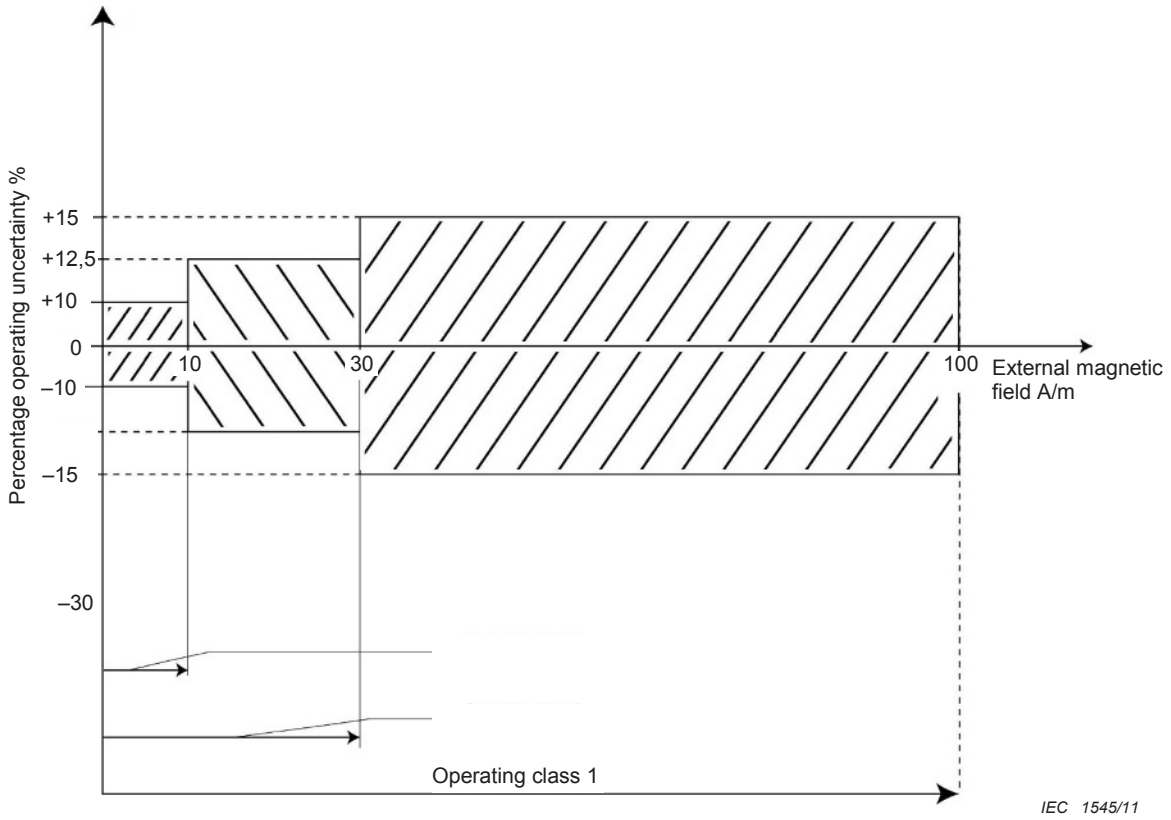

Figure 2 – Percentage operating uncertainty in relation to operating classes and external magnetic field and measuring ranges greater than10 mA

4.4 Reference conditions

The following reference conditions apply:

- mains frequency ±1 %;
- reference temperature: 23 °C ± 2 °C (E_3);
- reference position (E_1):
  - clamp jaws at 90° (±5°) to straight conductors,
  - conductors of 6 mm^2 cross section located within the centre (±5 %) of the clamp jaws
  - for differential method two straight conductors as close as possible are required (see Figure 3)
- rated supply voltage or rated voltage of battery (±1 %) (E_2);
- fiducial value of load current (±5 %) within 50 % and 100 % of the nominal range according to manufacturer's specification (E_{12});
- no low frequency external magnetic field (according to IEC 61000-4-8, Annex D) (E_{11});
- sinusoidal leakage current (THD <4 %) (E_9);
- current sensor insulated from earth or configuration according manufacturer's specification;
- rated range of burden according manufacturer's specification, if applicable.

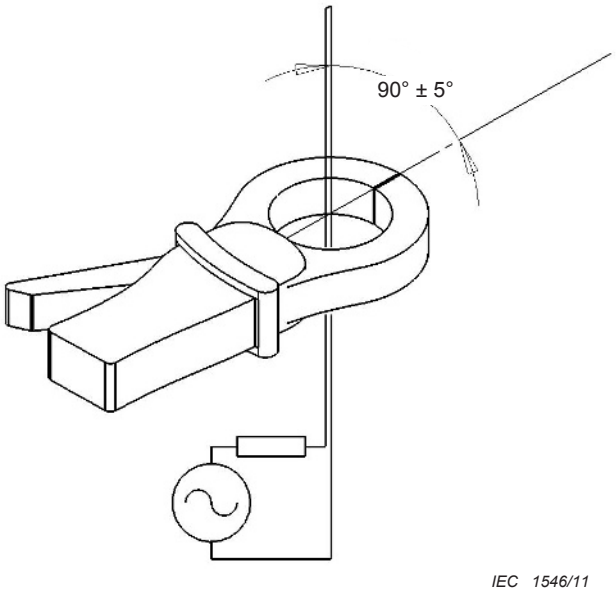

Figure 3 – Reference position for two straight conductors (for differential method)

4.5 Minimum rated operating conditions

The stated percentage operating uncertainties shall apply under the following rated operating conditions:

– reference position ±30°, for any position of conductors within the clamp jaws, if no fixing device is specified (E_1);

– for differential method, two straight parallel conductors of 6 mm^2 cross section as far apart as possible within the clamp jaws are required (Figure 4);

– rated range of supply voltage (or rated voltage range of batteries if applicable) (E_2);

– temperature range 0 °C to +35 °C (E_3) or extended range specified by the manufacturer;

– distorted waveform of leakage current, see Table 2 (E_9);

– external low frequency magnetic field within the limits of 4.2 (E_{11});

– rated range of load current (E_{12});

– touch current through circuit A1 according to IEC 61010-1 between hand-held parts (covered with metal foil) and earth. Conductor held at maximum common mode voltage and highest rated frequency (E_{13});

– rated range of frequency (E_{14});

– repeatability of the measurement readings due to at least 10 open / close cycles (E_{15}).

Table 2 – Calculation of percentage operating uncertainty

Intrinsic uncertainty or influence quantity	Reference conditions or specified operating range	Designation code	Requirements or tests in accordance with the relevant parts of IEC 61557	Type of test
Intrinsic uncertainty	Reference conditions	A	Part 13, 4.4, 6.2	R
Position	Reference position ±30°, for any position within the clamp jaws, if no fixing device is specified	E_1	Part 13, 4.5	T
Supply voltage	At the limits stated by the manufacturer	E_2	Part 1, 4.2, 4.3	T
Temperature	0°C to +35 °C or extended range specified by the manufacturer	E_3	Part 1, 4.2	T
Distorted waveform	5% 3rd harmonic of the nominal frequency at 0° 6% 5th. harmonic of the nominal frequency at 180° 5% 7th. harmonic of the nominal frequency at 0°	E_9	Part 1, 4.1	T
External low frequency magnetic field 15 Hz to 400 Hz according to IEC 61000-4-8	Operating class 1 at 100 A/m 30 A/m 10 A/m Operating class 2 at 30 A/m 10 A/m Operating class 3 at 10 A/m	E_{11}	Part 13 4.2	T
Load current	Nominal range of load current according to manufacturer's specification	E_{12}	Part 13, 4.1	T
Touch current caused by common mode voltage	Touch current through circuit A1 according to IEC 61010-1 between hand-held parts (covered with metal foil) and earth. Conductor held at maximum common mode voltage and highest rated mains frequency.	E_{13}	Part 13, 4.5	T
Frequency	Rated frequency range according to manufacturer's specification	E_{14}	Part 13, 4.1	T
Repeatability	Difference between the highest and lowest value of the intrinsic uncertainty	E_{15}	Part 13, 4.5	R
Percentage operating uncertainty	$B=\pm(/A/+1{,}15\sqrt{E_1^2+E_2^2+E_3^2+E_9^2+E_{11}^2+E_{12}^2+E_{13}^2+E_{14}^2+E_{15}^2}$		Part 13, 4.5	T

A = intrinsic uncertainty

E_n = variations

R = routine test

T = type test

$$B\,[\%] = \pm \frac{B}{\text{fiducial value}} \times 100\%$$

NOTE The intrinsic uncertainty A is to be determined at least at the upper and lower limit of the measuring range. Digitizing error, nonlinearity and traceability are to be taken into account. The highest value is to be used for the calculation of the operating uncertainty.

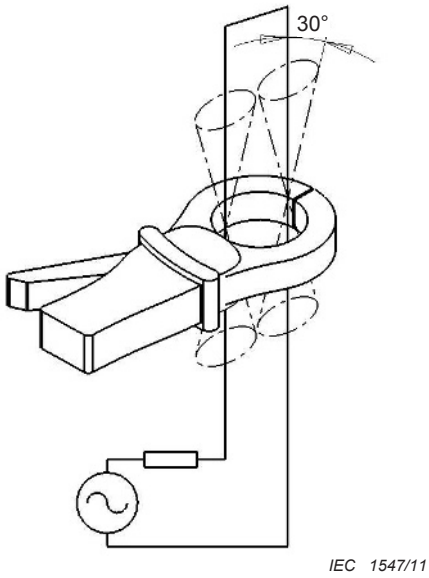

Figure 4 – Example of operating positions for differential method

4.6 Mechanical requirements

Current sensors of operating classes 1, 2 and 3 according to this standard shall comply with the requirements of IEC 61010-2-032:2002, Clause 8.

4.7 Pollution degree

Current sensors according to this standard shall be designed at least for pollution degree 2 according to IEC 61010-1.

4.8 Measurement category

Current sensors according to this standard shall be designed at least for measurement category III and minimum working voltage of 300 V according to IEC 61010-1.

4.9 Electromagnetic compatibility (EMC)

Current sensors according to this standard shall comply with the requirements of IEC 61326-2-2 or IEC 61326-1, whichever is applicable. Immunity values shall comply with those for industrial locations, emission values shall comply with those for residential locations.

5 Marking and operating instructions

5.1 Marking

5.1.1 Current sensors according to this standard shall be marked with a framed pictogram which warns not to exceed the permissible limits of external low frequency magnetic fields related to the operating class. This pictogram shall be clearly visible in normal position. The colour of the frame and pictogram shall contrast with the background. Figure 5 shows an example for an applicable pictogram for operating class 1.

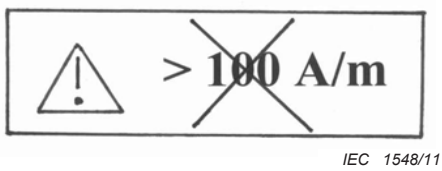

Figure 5 – Example for an applicable pictogram for operating class 1

5.1.2 Current sensors according to this standard shall be marked with the measuring range in accordance with 4.3.

In addition, maximum load current and rated range of frequency according to 4.1 shall be marked.

5.1.3 The intrinsic uncertainty shall not be marked on the current sensors.

NOTE The marking with the percentage operating uncertainty is allowed.

5.2 Operating instructions

5.2.1 Operating instructions of current sensors according to this standard shall be in compliance with the requirements of IEC 61557-1 and IEC 61010-2-032 and shall provide additional information according to 5.1.

5.2.2 Operating instructions shall include statements about optimized positioning of the current sensors and evaluation of influences caused by low frequency external magnetic fields and caused by contamination of the jaws. If necessary, instructions about fixing devices shall be added.

5.2.3 Operating instructions shall include statements about rated burden, if applicable.

5.2.4 Operating instructions shall include information about the relationship between load current and measuring range for the differential method.

5.2.5 Operating instructions shall include information about the recommended recalibration period.

5.2.6 The pictogram Figure 5 shall be listed under “Warning symbols” and shall be explained sufficiently.

6 Tests

In addition to IEC 61557-1 the following tests shall be performed.

6.1 Type tests

6.1.1 Electrical safety

The electrical safety of current sensors according to this standard shall be verified according to IEC 61010-2-032 (type test).

6.1.2 Variations

Variations for current sensors according to this standard shall be verified according to Table 2 under minimum rated operating conditions according to 4.5 (type test).

6.1.3 Percentage operating uncertainty

The percentage operating uncertainty B of current sensors according to this standard shall be calculated using the equation of Table 2 and taking into account the variations verified under 6.3 (type test).

6.1.4 Marking and operating instructions

The existence of information according to 5.2 shall be verified (type test).

6.2 Routine tests

6.2.1 Intrinsic uncertainty

The intrinsic uncertainty A of current sensors according to this standard under reference conditions specified by the manufacturer shall be verified (routine test).

6.2.2 Marking and operating instructions

The existence of marking and pictogram according to 5.1 shall be verified (routine test).

Annex A
(informative)

Examples of measurement applications

Figure A.1 shows an example for measurement of protective conductor current with the direct method.

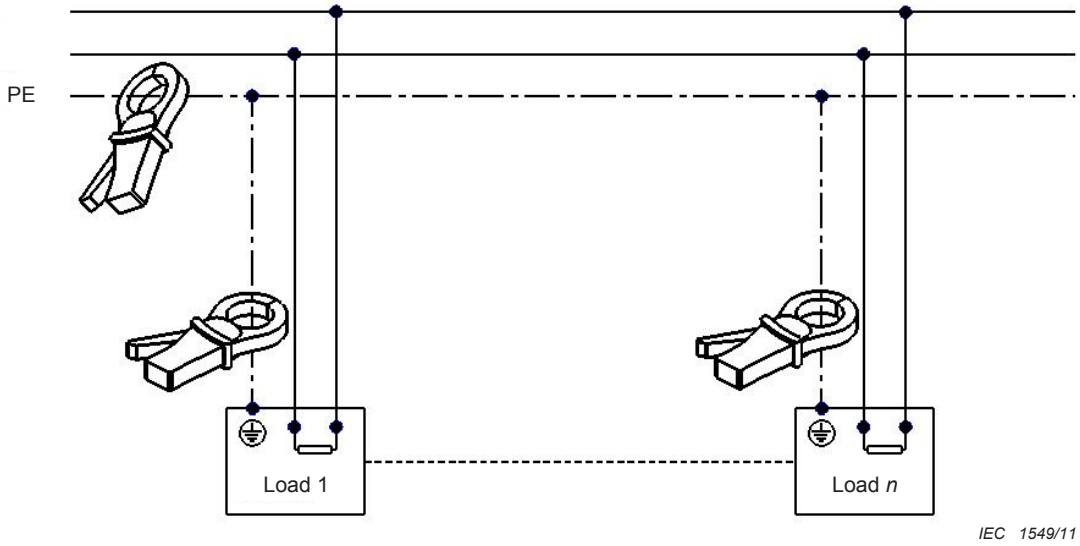

Figure A.1 – Example for measurement of protective conductor current – Direct method

Figure A.2 shows an example for measurement of leakage current and including protective conductor current with the differential method.

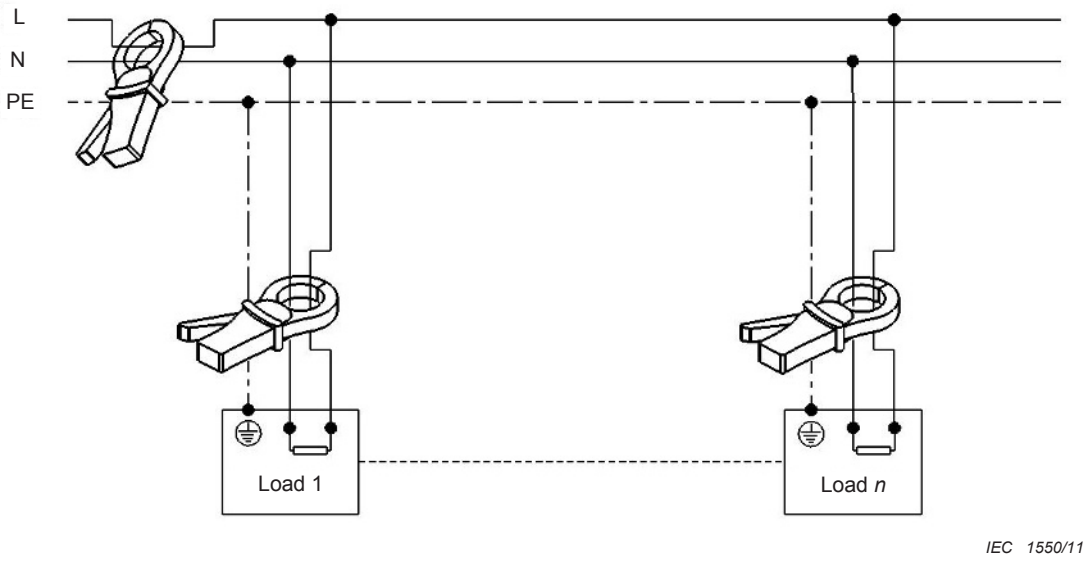

Figure A.2 – Example for measurement of leakage current including protective conductor current – Differential method

NOTE The examples in Figure A.1 and Figure A.2 are related to single-phase circuits. However, these examples of measurements are also valid for three-phase and three-phase and neutral circuits.

Bibliography

IEC 60359, *Electrical and electronic measurement equipment – Expression of the performance*

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