IEC 61010-2-032

Edition 4.0 2019-06
REDLINE VERSION

INTERNATIONAL STANDARD

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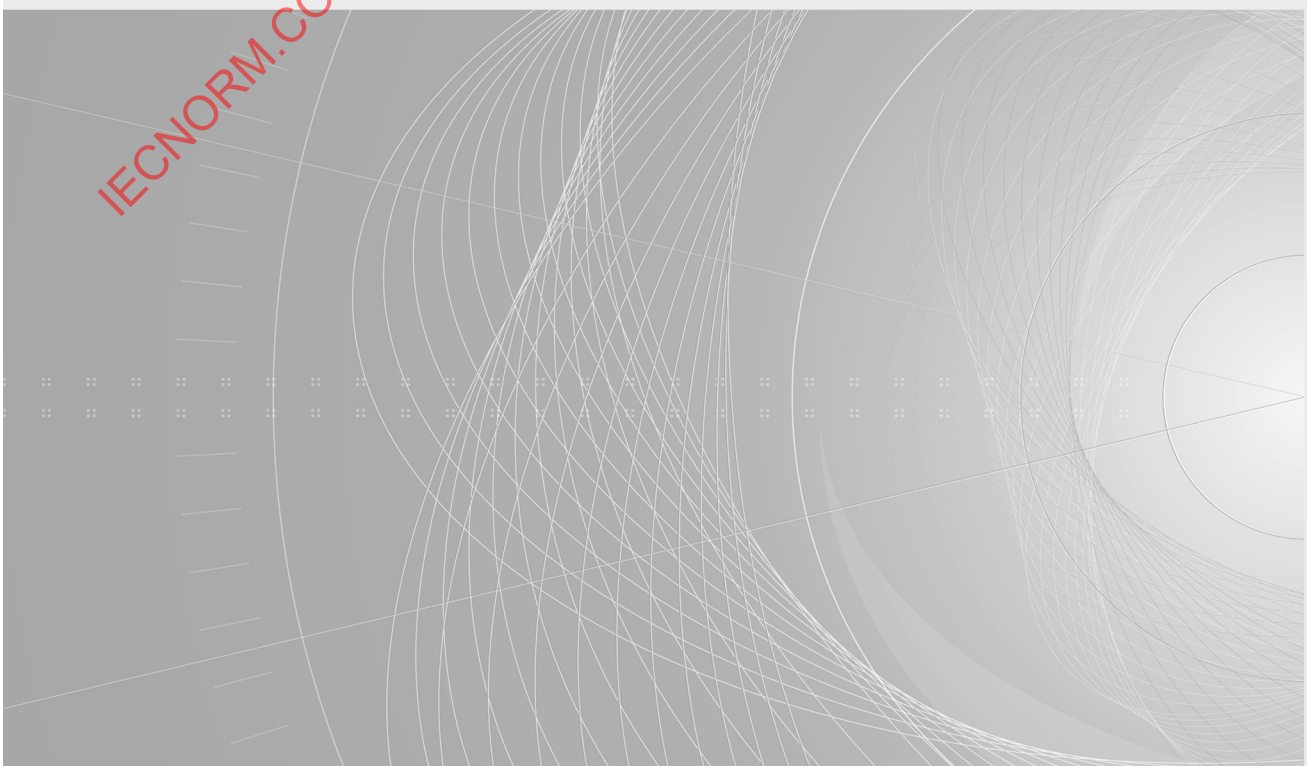
Safety requirements for electrical equipment for measurement, control and laboratory use –
Part 2-032: Particular requirements for HAND-HELD and hand-manipulated current sensors for electrical test and measurement



IEC 61010-2-032:2019-06 RLV(en)

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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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 19.080

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 61010-2-032 has been prepared by IEC technical committee 66: Safety of measuring, control and laboratory equipment.

This fourth edition cancels and replaces the third edition published in 2012. This edition constitutes a technical revision.

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

a) It has been indicated that current sensors used as FIXED EQUIPMENT are not within the scope of this document.

b) Fork-style current sensors have been added.

c) Requirements from Part 2-033 applicable to CLAMP MULTIMETERS that have a primary purpose of measuring voltage on live MAINS have been included in the new normative Annex EE.

d) CLEARANCES and CREEPAGE DISTANCES for measuring circuit TERMINALS exceeding 1 000 V a.c. or 1 414 V d.c. and for WET LOCATIONS have been specified.

e) Reduced CREEPAGE DISTANCES are allowed to be according to material group I for all insulating materials.

f) Requirements for input/output circuits of Type A, Type B and Type C current sensors have been detailed in 6.9.102.

g) Requirements for output circuit leads have been modified.

h) The JAW impact test has been limited to the front of the JAWS.

i) The abrasion test for cords of flexible current sensors has been removed and replaced by a pressure test at high temperature.

j) The voltage source for testing overvoltage limiting components or circuits may be limited to 400 V.

k) Reference to IEC 61010-031 for probe assemblies has been added.

l) Requirements for the prevention of TRANSIENT OVERVOLTAGES for MAINS voltage measuring circuits have been added.

m) Requirements for measuring circuits from 1 000 V to 3 000 V have been added.

n) An informative Annex CC about the dimensions of banana TERMINALS has been added.

o) A flowchart for insulation according to the type of circuit has been added in a new Annex DD.

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

FDIS	Report on voting
66/691/FDIS	66/695/RVD

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

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

A list of all parts of the IEC 61010 series, under the general title *Safety requirements for electrical equipment for measurement, control, and laboratory use*, can be found on the IEC website.

This Part 2-032 is to be used in conjunction with the latest edition of IEC 61010-1. It was established on the basis of the third edition (2010) of IEC 61010-1 and its Amendment 1 (2016), hereinafter referred to as Part 1.

This Part 2-032 supplements or modifies the corresponding clauses in IEC 61010-1 so as to convert that publication into the IEC standard: *Particular requirements for HAND-HELD and hand-manipulated current sensors for electrical test and measurement.*

Where a particular subclause of Part 1 is not mentioned in this Part 2-032, that subclause applies as far as is reasonable. Where this Part 2-032 states "addition", "modification", "replacement", or "deletion" the relevant requirement, test specification or note in Part 1 should be adapted accordingly.

In this standard:

a) the following print types are used:
   - requirements: in roman type;
   - NOTES: in small roman type;
   - *conformity and tests: in italic type;*
   - terms used throughout this standard which have been defined in Clause 3: SMALL ROMAN CAPITALS;

b) subclauses, figures, tables and notes which are additional to those in Part 1 are numbered starting from 101. Additional annexes are lettered starting from AA and additional list items are lettered from aa).

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

The contents of the corrigendum of February 2020 have been included in this copy.

INTRODUCTION

~~IEC 61010-1 specifies the safety requirements that are generally applicable to all equipment within its scope. For certain types of equipment, the requirements of IEC 61010-1 will be supplemented or modified by the special requirements of one, or more than one, particular part 2s of the standard which are to be read in conjunction with the Part 1 requirements.~~

~~This Part 2-032 specifies the safety requirements that are generally applicable to HAND-HELD and hand-manipulated current sensors (see Clause 1).~~

~~Part 2-030 specifies the safety requirements for testing and measuring circuits which are connected for test or measurement purposes to devices or circuits outside the measurement equipment itself.~~

~~Part 2-033 specifies the safety requirements for handheld METERS that have a primary purpose of measuring voltage on a live MAINS CIRCUIT.~~

~~Except for protective bonding, all requirements of Part 2-030 have been included into Part 2-032. Equipment within the scopes of Part 2-030 and Part2-032 are considered to be covered by the requirements of Part 2-032. However, For equipment within the scope of both Part 2-032 and Part 2-033, the two standards are to be read in conjunction.~~

Part 2-030 specifies the safety requirements for equipment with testing and measuring circuits which are connected for test or measurement purposes to devices or circuits outside the measurement equipment itself. Requirements of Part 2-030 have been included in this Part 2-032. Equipment within the scopes of both Part 2-030 and Part 2-032 are considered to be covered by the requirements of this Part 2-032.

Part 2-033 specifies the safety requirements for hand-held multimeters that have the primary purpose of measuring voltage on live MAINS. For equipment within the scope of Part 2-032 and Part 2-033, only this Part 2-032 is applicable.

Part 2-034 specifies the safety requirements for measurement equipment for insulation resistance and test equipment for electric strength which are connected to units, lines or circuits for test or measurement purposes. For equipment within the scope of Part 2-032 and Part 2-034, both documents should be read in conjunction.

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

1 Scope and object

This clause of Part 1 is applicable except as follows:

1.1.1 Equipment included in scope

Replace the existing text with the following:

This part of IEC 61010 specifies safety requirements for HAND-HELD and hand-manipulated current sensors described below.

These current sensors are for measuring, detecting or injecting current, or indicating current waveforms on circuits without physically opening the current path of the circuit being measured. They ~~may~~ can be stand-alone current sensors or accessories to other equipment or parts of combined equipment (see Figure 101). These include measurement circuits which are part of electrical test and measurement equipment, laboratory equipment, or process control equipment. ~~The existence of~~ These current sensors and circuits ~~in equipment requires~~ need additional protective means between the current sensor, the circuit and an OPERATOR.

~~NOTE 1 This part includes also the requirements of Part 2-030. Testing and measuring circuits that are not within the scope of this part are considered to be covered by the requirements of Part 1 or other parts 2s of IEC 61010, and then will also need to meet the requirements of these other parts with the exception of Part 2-030. Current clamp meters and similar currents sensors that have a primary purpose of measuring voltage on a live MAINS CIRCUIT are also within the scope of Part 2-033.~~

NOTE 1 Combined equipment is equipment that is electrically connected to a current sensor by means of a permanent connection which can be detached only by the use of a TOOL.

NOTE 2 Some current sensors are also known as current clamps, CLAMP MULTIMETERS and current probes.

Current sensors ~~require hand manipulation~~ are hand-manipulated before and/or after a test or measurement, but do not necessarily need to be HAND-HELD during the test or measurement. Current sensors used as FIXED EQUIPMENT are not within the scope of this document.

~~NOTE 3 Some current sensors designed for portable use can also be used for fixed installations.~~

The following types of current sensors are covered:

a) Type A: a current sensor designed to be applied ~~around~~ to or removed from ~~UNINSULATED~~ HAZARDOUS LIVE UNINSULATED CONDUCTORS. Type A current sensors have defined HAND-HELD or hand-manipulated parts providing protection against electric shock from the conductor being measured, and also have protection against short-circuits between wires and between busbars during clamping.

b) Type B: a current sensor which has protection against short-circuits between wires or busbars during clamping but without defined HAND-HELD or hand-manipulated parts which provide protection against electric shock during clamping. Additional protective means are necessary to avoid electric shock from HAZARDOUS LIVE conductors which cannot be de-energised during application or removal of the current sensor.

EXAMPLE 1 Flexible current sensors.

c) Type C: a current sensor without protection against short-circuits between wires or busbars during clamping. Type C current sensors are intended to be applied to or removed from ~~UNINSULATED~~ HAZARDOUS LIVE UNINSULATED CONDUCTORS or from non-limited-energy circuit conductors only when they are de-energised.

EXAMPLE 2 Split-core transducers.

d) Type D: a current sensor designed to be applied ~~around~~ to or removed from insulated conductors or from limited-energy circuit conductors.

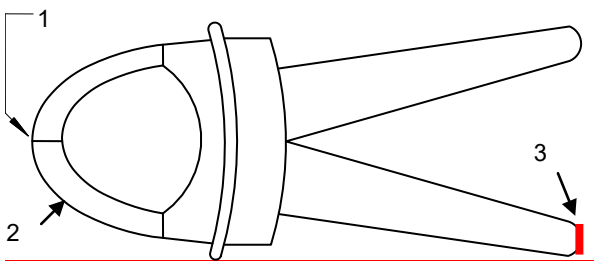
~~A Type D current sensor does not need protection against short-circuits during clamping and has no defined HAND-HELD or hand-manipulated parts providing protection against electric shock from the conductor being measured.~~

EXAMPLE 3 Current probes for oscilloscopes and earth leakage current detectors.

~~NOTE 4~~ All current sensors can also be used ~~around~~ with insulated conductors. In this case, HAZARDS are limited to acceptable levels by the insulation of the conductors.

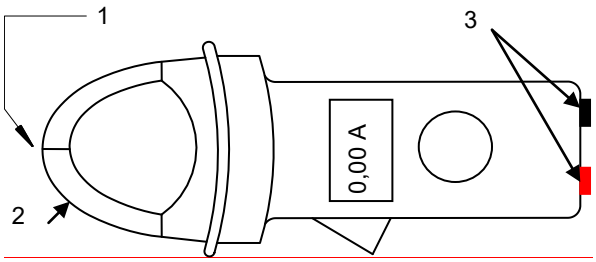
Additional requirements for CLAMP MULTIMETERS are given in Annex EE.

Figure 101 shows graphical representations of typical current sensors for illustration purposes. Current sensors can look different depending on the design.



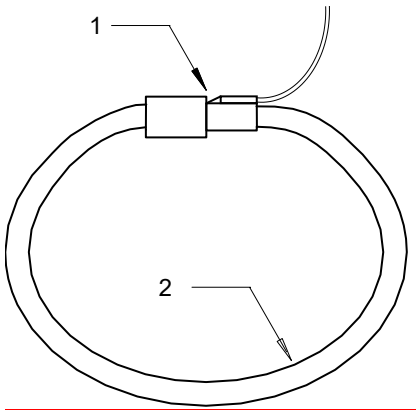
~~Type A~~

~~Current sensor as an accessory~~



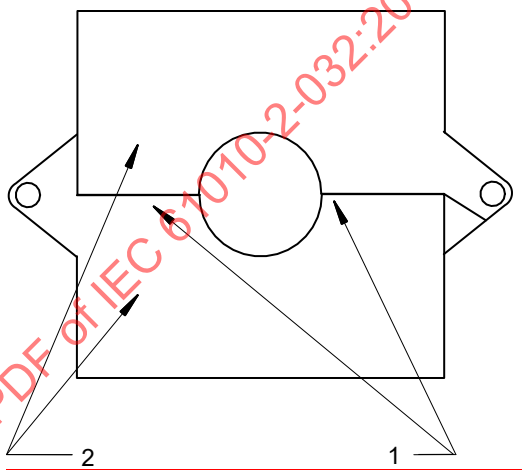
~~Type A~~

~~Current sensor with self-contained measuring functions or with additional measuring functions~~



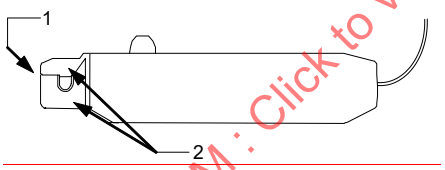
~~Type B~~

~~Flexible current sensor~~



~~Type C~~

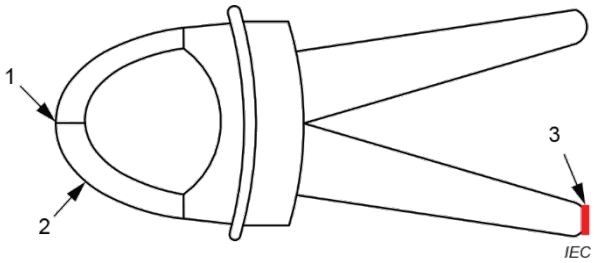
~~Split-core current sensor~~



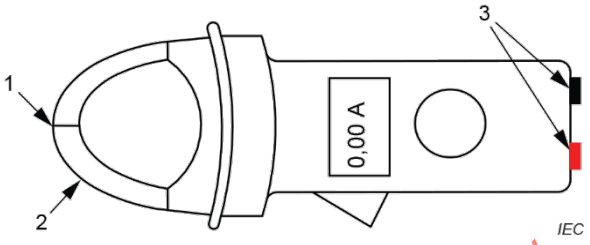
~~Type D~~

~~Current sensor for non HAZARDOUS LIVE applications (shown with a sliding JAW)~~

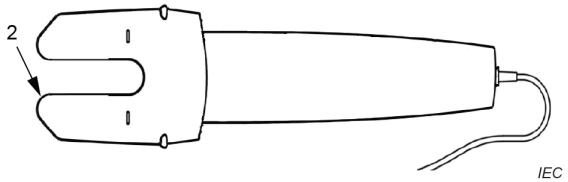
IEC 1865/12



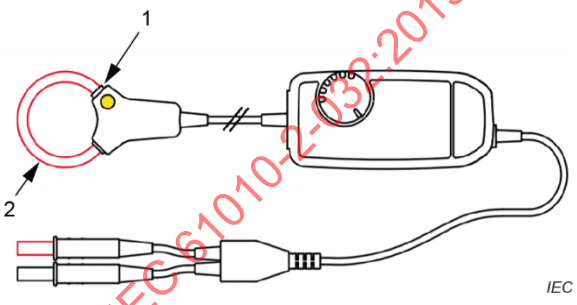
Type A current sensor as an accessory



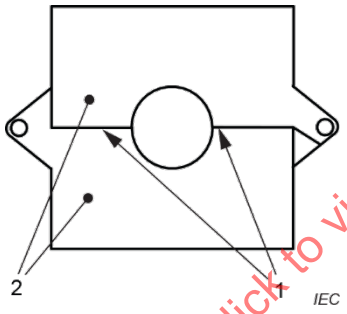
Type A current sensor with self-contained and/or additional measuring functions



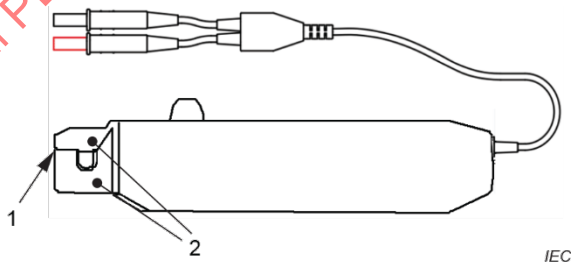
Type A current sensor with fork-style JAWS



Type B flexible current sensor part of a piece of combined equipment



Type C split-core current sensor



Type D current sensor for non-HAZARDOUS LIVE applications (shown with a sliding JAW)

Key

1 JAW END(S)

2 JAW

3 measuring circuit TERMINALS

Figure 101 – Examples of current sensors and their parts

1.2.1 Aspects included in scope

Add the following ~~two~~ three new paragraphs at the end of the subclause:

Requirements for protection against HAZARDS resulting from NORMAL USE and REASONABLY FORESEEABLE MISUSE of measuring circuits are given in Clause 101.

Requirements for prevention of HAZARD from arc flash and short-circuits are given in Clause 102.

Requirements for reliance on the displayed value of CLAMP MULTIMETERS are given in Clause EE.5 .

2 Normative references

This clause of Part 1 is applicable except as follows:

Replace "IEC 61010-031" with the following new reference:

IEC 61010-031:2015, *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 61010-031:2015/AMD1:2018

Replace "IEC 61180-1 (all parts)", "IEC 61180-1" and "IEC 61180-2", with the following new reference:

IEC 61180, *High-voltage test techniques for low-voltage equipment – Definitions, test and procedure requirements, test equipment*

3 Terms and definitions

This clause of Part 1 is applicable except as follows:

3.1 Equipment and states of equipment

Add the following two new terms and definitions:

3.1.101
HAND-HELD
intended to be supported by one hand during NORMAL USE

3.1.102
CLAMP MULTIMETER
HAND-HELD multi-range and multifunction measuring instrument intended to measure current on a live MAINS without physically opening the conductors, voltage on a live MAINS and other electrical quantities such as resistance

3.2 Parts and accessories

Add the following two new terms and definitions:

3.2.101
JAW
part of a current sensor which surrounds or partially surrounds the conductor under test

3.2.102
JAW END
part of the JAW where opening occurs while clamping around a conductor

3.5 Safety terms

Replace the definition~~s~~ of 3.5.4 ~~and 3.5.5~~ with the following new definition~~s~~:

3.5.4
MAINS
~~low-voltage electricity supply system to which the current sensor concerned is designed to be connected for the purpose of powering the current sensor or for measurements~~
electricity supply system

~~3.5.5~~
~~MAINS CIRCUIT~~
~~circuit which is intended to be directly connected to the MAINS for the purpose of powering the current sensor or for measurements~~

Add the following new term and definition:

3.5.101
MEASUREMENT CATEGORY
classification of testing and measuring circuits according to the type of MAINS ~~CIRCUITS~~ to which they are intended to be connected

Note 1 to entry: MEASUREMENT CATEGORIES take into account OVERVOLTAGE CATEGORIES, short-circuit current levels, the location in the building installation ~~at which~~ where the test or measurement is to be made and some forms of energy limitation or transient protection included in the building installation. See Annex AA for more information.

3.6 Insulation

Add the following new term and definition:

3.6.101
UNINSULATED CONDUCTOR
conductor not insulated by solid insulation or insulated by solid insulation which does not meet the requirements for BASIC INSULATION for the relevant voltage to earth

4 Tests

This clause of Part 1 is applicable except as follows:

4.3.2.5 MAINS supply

Replace the existing title and text with:

4.3.2.5 Power supply

The following requirements apply.

a) The MAINS supply voltage shall be between 90 % and 110 % of any RATED supply voltage for which the equipment can be set or, if the equipment is RATED for a greater fluctuation, at any supply voltage within the fluctuation range.

b) The MAINS frequency shall be any RATED frequency.

c) Equipment for both a.c. and d.c. shall be connected to an a.c. or d.c. supply.

d) Equipment powered by single-phase a.c. MAINS supply shall be connected both with normal and reverse polarity.

e) If the means of connection permit reversal, battery-operated and d.c. equipment shall be connected with both reverse and normal polarity.

4.3.2.6 Input and output voltages

Replace the existing title and text with:

4.3.2.6 Input and output voltages or currents

Input and output voltages or currents, including floating voltages but excluding the MAINS supply voltage, shall be set to any voltage or current within their RATED range, in normal and reverse polarity if possible.

4.4.2.8 Outputs

Replace the text with the following:

Outputs shall be open-circuited and short-circuited, one at a time.

5 Marking and documentation

This clause of Part 1 is applicable except as follows:

5.1.2 Identification

Add the following new items and a new paragraph after the note to item b):

aa) for current sensors designed for use only with a specific model of equipment, a clear identification of the equipment, or with symbol 14 of Table 1 if this information is available only in the documentation;

bb) for Type A current sensors, with symbol 102 of Table 1;

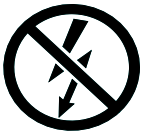
cc) for Type B and Type C current sensors, with symbol 101 of Table 1;

dd) for Type D current sensors, with symbol 101 and symbol 14 of Table 1 ~~is permitted with an additional marking (see 5.1.5.102)~~.

The relevant symbol (14, 101 or 102) shall be marked adjacent to the JAWS or to the marking of the MEASUREMENT CATEGORY for the JAWS, if present (see 5.1.5.101 and 5.1.5.102).

Table 1 – Symbols

Add the following two new symbols:

Number	Symbol	Reference	Description
101			Do not apply ~~around~~ current sensor to or remove from ~~UNINSULATED~~ HAZARDOUS LIVE UNINSULATED CONDUCTORS, which may render electric shock, electric burn, or arc flash
102		IEC 60417-6300 (2016-03)	Application ~~around~~ of current sensor to and removal from ~~UNINSULATED~~ HAZARDOUS LIVE UNINSULATED CONDUCTORS is permitted

5.1.5 TERMINALS, connections and operating devices

Add the following two new subclauses:

5.1.5.101 Measuring circuit TERMINALS

5.1.5.101.1 General

Except as permitted in 5.1.5.101.4:

a) the value of the RATED voltage to earth of measuring circuit TERMINALS shall be marked, and

b) the value of the RATED voltage or the RATED current, as applicable, of each pair or set of measuring circuit TERMINALS that are intended to be used together shall be marked, and

c) the pertinent MEASUREMENT CATEGORY for each individual, pair, or set of measuring circuit TERMINALS, or symbol 14 of Table 1 shall be marked as specified in 5.1.5.101.2 and 5.1.5.101.3, if applicable.

Measuring circuit TERMINALS are usually arranged in pairs or sets. Each pair or set of TERMINALS may have a RATED voltage or a RATED current, or both, within that set, and each individual TERMINAL may have a RATED voltage to earth. For some ~~equipment~~ current sensors, the RATED voltage between TERMINALS may be different from the RATED voltage to earth. Markings shall be clear to avoid misunderstanding.

Markings shall be placed adjacent to the TERMINALS. However, if there is insufficient space (as in multi-input ~~equipment~~ current sensors), the marking may be on the RATING plate or scale plate, or the TERMINAL may be marked with symbol 14 of Table 1.

For any set of measuring circuit TERMINALS, symbol 14 of Table 1 does not need to be marked more than once, if it is close to the TERMINALS.

Conformity is checked by inspection and, if applicable, as specified in 5.1.5.101.2 *and* 5.1.5.101.3*, taking the exceptions in* 5.1.5.101.4 *into account.*

5.1.5.101.2 Measuring circuit TERMINALS rated for MEASUREMENT CATEGORIES ~~II, III or IV~~

The relevant MEASUREMENT CATEGORY shall be marked for TERMINALS of measuring ~~circuit TERMINALS~~ circuits RATED for ~~measurements within~~ MEASUREMENT CATEGORIES ~~II, III or IV~~. The MEASUREMENT CATEGORY markings shall be "CAT II", "CAT III" or "CAT IV" as applicable.

Marking those TERMINALS with more than one type of MEASUREMENT CATEGORY and its RATED voltage to earth is permissible ~~(see also 5.1.5.101.1)~~.

Conformity is checked by inspection.

5.1.5.101.3 Measuring circuit TERMINALS RATED for connection to voltages above the levels of 6.3.1

Symbol 14 of Table 1 shall be marked for measuring circuit TERMINALS RATED for connection to voltages above the levels of 6.3.1, but that are not RATED for ~~measurements within~~ MEASUREMENT CATEGORIES ~~II, III or IV~~ (see also 5.4.2 bb)).

Conformity is checked by inspection.

5.1.5.101.4 ~~Low voltage, permanently connected, or dedicated measuring circuit TERMINALS~~ Measuring circuit TERMINALS which are permanently connected, dedicated or for non-HAZARDOUS LIVE voltages

Measuring circuit TERMINALS do not need to be marked if:

a) they are intended to be permanently connected and not ACCESSIBLE (see 5.4.3 aa) and bb)), or

b) they are dedicated only for connection to specific TERMINALS of other equipment (see also 6.101.3), or

c) it is obvious from other indications that the RATED voltage is below the levels of 6.3.1.

NOTE Examples of acceptable indications that the inputs are intended to be less than the levels of 6.3.1 include:

– the full scale deflection marking of a single-range indicating voltmeter or ammeter;

– the maximum range marking of a voltage selector switch;

– a marked voltage or power RATING expressed in dB, mW or W, where the equivalent value, as explained in the documentation, is below ~~33~~ 30 V a.c.

Conformity is checked by inspection.

5.1.5.102 Voltage and current RATINGS of JAWS

Current sensors that are intended to be used on UNINSULATED CONDUCTORS shall be marked with the value of the RATED voltage to earth of the JAWS.

~~Current sensors that are intended to be used only on insulated conductors shall be marked to indicate that the current sensor must not be used on UNINSULATED conductors, or with symbol 14.~~

JAWS of Type A, Type B or Type C current sensors RATED for ~~measurements within~~ MEASUREMENT CATEGORIES ~~II, III or IV~~, shall be marked with the relevant MEASUREMENT CATEGORY adjacent to the voltage to earth marking. The MEASUREMENT CATEGORY markings shall be "CAT II", "CAT III" or "CAT IV" as applicable.

JAWS and output circuit TERMINALS of Type D current sensors shall not be marked with any MEASUREMENT CATEGORY.

The value of the RATED current shall be marked on or close to the JAWS. The nature of the current shall also be marked unless the marked value applies to both a.c. and d.c. ~~current~~.

Conformity is checked by inspection.

5.4.1 General

Add the following new items to the list and a new paragraph:

aa) information about each relevant MEASUREMENT CATEGORY if the measuring circuit is RATED for MEASUREMENT CATEGORIES (see 5.1.5.101.2);

bb) for measuring circuits that are not RATED for MEASUREMENT CATEGORIES, but that could be misused by connection to such circuits, a warning not to use the current sensor for measurements on MAINS, and a detailed RATING including TRANSIENT OVERVOLTAGES (see AA.2.4 for more information).

Some current sensors may have multiple MEASUREMENT CATEGORY RATINGS for the same measuring circuit. For such current sensors, the documentation shall clearly identify the MEASUREMENT CATEGORIES where the current sensor is intended to be used and where it shall not be used.

5.4.2 Equipment RATINGS

Add the following two new items to the list and a new paragraph:

aa) information about each relevant MEASUREMENT CATEGORY if the measuring circuit ~~has a RATING~~ is RATED for MEASUREMENT ~~CATEGORY II, III or IV~~ CATEGORIES (see 5.1.5.101.2 and 5.1.5.102);

bb) for Type A, Type B and Type C current sensors that ~~do not have a RATING~~ are not RATED for MEASUREMENT ~~CATEGORY II, III or IV~~ CATEGORIES, but that could be misused by connection to such circuits, a warning not to use the current sensor for measurements on MAINS ~~CIRCUITS~~, and a detailed RATING including TRANSIENT OVERVOLTAGES (see AA.2.4 for more information).

If the current sensor has multiple MEASUREMENT CATEGORY RATINGS for the same measuring circuit, the documentation shall clearly identify the MEASUREMENT CATEGORIES where the current sensor is intended to be used and where it ~~must~~ shall not be used.

5.4.3 Equipment installation

Add the following two new items to the list:

aa) for measuring circuit TERMINALS intended for permanent connection and that are RATED for MEASUREMENT CATEGORIES ~~II, III or IV~~, information regarding the MEASUREMENT CATEGORY, RATED voltages or RATED currents as applicable (see 5.1.5.101.2 and 5.1.5.102);

bb) for measuring circuit TERMINALS intended for permanent connection and that are not RATED for MEASUREMENT CATEGORIES ~~II, III or IV~~, information regarding the RATED voltages, RATED currents, and RATED TRANSIENT OVERVOLTAGES as applicable (see 5.1.5.101.4 and 5.1.5.102).

5.4.4 Equipment operation

Replace the existing text with the following:

Instructions for use shall include, if applicable:

a) identification and description of operating controls and their use in all operating modes;

b) for current sensors designed for use only with a specific model of equipment, a clear identification of the equipment;

c) specifications of limits for intermittent operation;

d) specifications of limits of the current versus the frequency if the magnetic circuit can reach a hazardous temperature;

e) explanations of symbols related to safety which are used on the ~~equipment~~ current sensor;

f) instructions for interconnection to accessories and other equipment, including indication of suitable accessories and detachable parts;

g) instructions for replacement of consumable materials;

h) instructions for cleaning and decontamination;

i) instructions for the application and removal of the current sensor;

j) instructions to de-energise the installation on which the current is measured, or to adopt safe operating procedures when working on HAZARDOUS LIVE installations, during application and removal of Type B current sensors;

k) instructions to de-energise the installation on which the current is measured, when working on HAZARDOUS LIVE installations, or non-limited-energy installations during application and removal of Type C current sensors;

l) instructions about the function of the ~~tactile indicator or~~ PROTECTIVE BARRIER, indicating the limit of safe access of the HAND-HELD part;

m) a warning to the OPERATOR that Type D current sensors are only for use around insulated conductors or limited energy circuit conductors;

n) a warning to the OPERATOR that individual protective equipment should be used if HAZARDOUS LIVE parts in the installation where measurement is to be carried out could be ACCESSIBLE;

o) a warning to the OPERATOR not to use a flexible current sensor if the wear indicator of the flexible cord used for the JAW of the flexible current sensor is visible (see ~~6.9.101.4~~ 8.103);

p) a warning to the OPERATOR not to use a current sensor if the wear indicator in the JAW END is visible (see ~~6.9.101.3~~ 8.104);

q) a warning to the OPERATOR not to use a current sensor above its RATED frequency, if the magnetic circuit can reach a hazardous temperature (see 10.101).

There shall be a statement in the instructions that, if the current sensor is used in a manner not specified by the manufacturer, the protection provided by the current sensor may be impaired.

Conformity is checked by inspection.

6 Protection against electric shock

This clause of Part 1 is applicable except as follows:

6.1.2 Exceptions

Add the following new item ~~aa)~~ to the list:

aa) conductive parts of a JAW END, provided that they meet the requirements of 6.9.101.

6.5.2 PROTECTIVE BONDING

Replace the existing title with the following and delete the text ~~with~~:

6.5.2 ~~(Void)~~ Not used

6.6 Connections to external circuits

Add the following two new subclauses:

6.6.101 Measuring circuit TERMINALS

The conductive parts of each unmated measuring circuit TERMINAL which could become HAZARDOUS LIVE when the highest RATED voltage is applied to other measuring circuit TERMINALS on the ~~equipment~~ current sensor shall be separated by at least:

a) for TERMINALS with voltage RATING up to 1 000 V a.c. or 1 500 V d.c., the applicable CLEARANCE and CREEPAGE DISTANCE of Table 101 from the closest approach of the test finger touching the external parts of the TERMINAL in the least favourable position (see Figure 1);

b) for TERMINALS with voltage RATING exceeding 1 000 V a.c. or 1 500 V d.c., 2,8 mm for the CLEARANCE and CREEPAGE DISTANCE from the closest approach of the test finger touching the external parts of the TERMINAL in the least favourable position. These TERMINALS shall also withstand the voltage test of 6.8 with a test voltage equal to the RATED voltage of the TERMINAL multiplied by 1,25 applied between the closest approach of the test finger touching the external parts of the TERMINAL in the least favourable position and the other measuring circuit TERMINALS.

EXAMPLE For a 4 000 V a.c. r.m.s. RATED voltage, the test voltage is 5 000 V a.c. r.m.s. (7 070 V peak). The calculated CLEARANCE is 13,1 mm according to D_2 in Table K.15. For homogeneous fields, a lower CLEARANCE value can be achieved by testing (see IEC 60664-1 for more information about homogeneous fields).

c) for WET LOCATIONS, there are no CLEARANCE and CREEPAGE DISTANCE requirements for voltages between 16 V a.c. r.m.s. and 30 V a.c. r.m.s., or between 35 V d.c. and 60 V d.c., but conductive parts of unmated measuring circuit TERMINALS shall not be ACCESSIBLE.

Table 101 – CLEARANCES and CREEPAGE DISTANCES for measuring circuit TERMINALS with HAZARDOUS LIVE conductive parts up to 1 000 V a.c. or 1 500 V d.c.

~~Voltage on conductive parts of TERMINAL~~		~~CLEARANCE and CREEPAGE DISTANCE~~
~~V a.c. r.m.s.~~	~~V d.c.~~	~~mm~~
~~≥ 33 ≤ 300~~	~~≥ 70 ≤ 414~~	~~0,8~~
~~> 300 ≤ 600~~	~~> 414 ≤ 848~~	~~1,0~~
~~> 600 ≤ 1 000~~	~~> 848 ≤ 1 414~~	~~2,6~~
~~NOTE For WET LOCATIONS, there are no CLEARANCE and CREEPAGE DISTANCE requirements for voltages between 16 V a.c. r.m.s. and 33 V a.c. r.m.s., or between 35 V d.c. and 70 V d.c., but conductive parts of unmated measuring circuit TERMINALS shall not be ACCESSIBLE. The values in this table are not applicable to voltages below HAZARDOUS LIVE voltages (see 6.3.1 a)).~~		

Voltage on conductive parts of TERMINAL V a.c. r.m.s. and V d.c.	CLEARANCE and CREEPAGE DISTANCE mm
≥ 30 ≤ 300	0,8
> 300 ≤ 600	1,0
> 600 ≤ 1 000	2,6
> 1 000 ≤ 1 500 [a]	2,8
NOTE The values in this table are not applicable to voltages below HAZARDOUS LIVE voltages (see 6.3.1 a)). [a] Only for d.c. voltage.	

Annex CC provides information regarding the recommended dimensions of 4 mm "banana" TERMINALS.

Conformity is checked by inspection ~~and~~, by the determination of ACCESSIBLE parts, by measurement of the applicable CLEARANCES and CREEPAGE DISTANCES, and if applicable, by the voltage test of 6.8.

6.6.102 Specialized measuring circuit TERMINALS

Components, sensors, and devices intended to be connected to specialized measuring circuit TERMINALS shall not be both ACCESSIBLE and HAZARDOUS LIVE, in either NORMAL CONDITION or in SINGLE-FAULT CONDITION, even when the highest RATED voltage is applied to any other measuring circuit TERMINAL.

NOTE These specialized TERMINALS include, but are not limited to, TERMINALS for semiconductor measuring functions, capacitance measurements, and thermocouple sockets.

Conformity is checked by inspection and measurement. Components, sensors, and devices intended to be connected to specialized measuring circuit TERMINALS are connected. The measurements of 6.3 are made to establish that the levels of 6.3.1 and 6.3.2 are not exceeded when each of the following voltages is applied to each other measuring circuit TERMINAL, if applicable:

a) highest RATED a.c. voltage at any RATED MAINS frequency;

b) highest RATED d.c. voltage;

c) highest RATED a.c. voltage at the related maximum RATED measurement frequency.

6.7.1.3 CREEPAGE DISTANCES

Add the following new paragraph after the third paragraph:

For HAND-HELD EQUIPMENT not powered from the MAINS or the measuring circuit, CREEPAGE DISTANCES according to material group I are allowed to be used for other materials.

For TERMINALS of HAND-HELD EQUIPMENT intended to be connected only to a HAND-HELD probe assembly complying with Part 031, CREEPAGE DISTANCES according to material group I are allowed to be used for the insulating material of the TERMINALS.

6.7.1.5 Requirements for insulation according to type of circuit

~~*Addition:*~~

~~*Add the following new item ci) after item v) of the list of item e)*~~

~~ci) the circuit is a measuring circuit where MEASUREMENT CATEGORIES do not apply.~~

~~*Add the following new item aa) to the list:*~~

~~aa) in K.101 for measuring circuits of MEASUREMENT CATEGORIES II, III and IV.~~

~~*Replacement:*~~

~~*Replace Note 2 with the following:*~~

~~NOTE 2 (Void)~~

Replace the text with the following:

Requirements for insulation in particular types of circuits are specified as follows:

a) in 6.7.2 for MAINS CIRCUITS of OVERVOLTAGE CATEGORY II with a nominal supply voltage up to 300 V;

NOTE 1 See Annex I for nominal voltages of MAINS supplies.

b) in 6.7.3 for secondary circuits separated from the circuits in a) only by means of a transformer;

c) in Clause K.1 for MAINS CIRCUITS of OVERVOLTAGE CATEGORY III or IV or for OVERVOLTAGE CATEGORY II over 300 V;

d) in Clause K.2 for secondary circuits separated from the circuits in c) only by means of a transformer;

e) in Clause K.3 for circuits that have one or more of the following characteristics:

1) the maximum possible TRANSIENT OVERVOLTAGE is limited by the supply source or within the current sensor to a known level below the level assumed for the MAINS CIRCUIT;
2) the maximum possible TRANSIENT OVERVOLTAGE is above the level assumed for the MAINS CIRCUIT;
3) the WORKING VOLTAGE is the sum of voltages from more than one circuit, or is a mixed voltage;
4) the WORKING VOLTAGE includes a recurring peak voltage that may include a periodic non-sinusoidal waveform or a non-periodic waveform that occurs with some regularity;
5) the WORKING VOLTAGE has a frequency above 30 kHz;
6) the circuit is a measuring circuit where MEASUREMENT CATEGORIES do not apply.

f) in Clause K.101 for measuring circuits RATED for MEASUREMENT CATEGORIES.

NOTE 2 These requirements are illustrated in the flowchart of Annex DD, Figure DD.1.

The TRANSIENT OVERVOLTAGE level for the MAINS corresponds to the "required RATED impulse voltage of equipment" value specified in Table 443.2 of IEC 60364-4-44:2007/AMD1:2015.

6.8.3.1 The a.c. voltage test

Replace the first sentence with the following sentence:

The voltage tester shall be capable of maintaining the test voltage throughout the test within ±5 % of the specified value.

6.9 Constructional requirements for protection against electric shock

Add the following two new subclauses:

~~**6.9.101 Insulation requirements for JAWS and JAW ENDS**~~

~~**6.9.101.1 Pre-treatment of the JAW ENDS**~~

~~This pre-treatment shall be performed only for Type A and Type B current sensors RATED for MEASUREMENT CATEGORIES III and IV.~~

~~The pre-treatment is performed to simulate the wear of the JAWS during insertion and removal. It is not applicable to current sensors with a sliding JAW and to flexible current sensors.~~

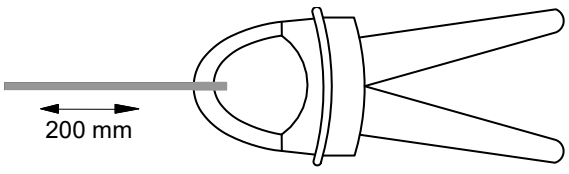
~~*Three samples of the current sensor in NORMAL CONDITION and three samples of the current sensor that have been conditioned as specified in 10.5.2 a) are treated as follows.*~~

~~*A pre-treatment plate is prepared consisting of a rigid material, covered on both sides by emery cloth. The pre-treatment plate is a minimum of 50 mm by 450 mm, with a thickness not exceeding 2 mm. The emery cloth shall be No. 120 grit, with aluminium oxide abrasive bound in an enclosed coating and with a cloth backing.*~~

~~*With the JAWS open, the current sensor is positioned as shown in Figure 102 and then the JAWS are closed.*~~

~~*The current sensor is moved along the pre-treatment plate a distance of 200 mm, or a lesser amount if restricted by the design, for 50 cycles – one cycle consisting of one forward and one reverse movement – so as to abrade the closing point of the JAWS (see Figure 102). If the insulation of the JAW ENDS has a wear indicator, the treatment is terminated if the wear indicator becomes visible before 50 cycles are completed. The emery cloth is replaced after each sample has been treated.*~~

~~NOTE With regard to JAW ENDS, a wear indicator is a feature designed to be not visible until a limit of wear has been reached.~~



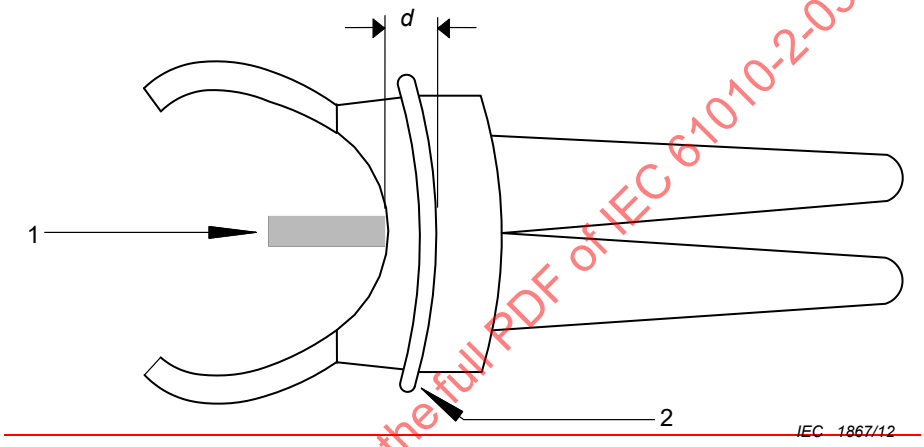
~~**Figure 102 – Pre-treatment of the JAW ENDS**~~

6.9.101.2 Protection against touching the HAZARDOUS LIVE conductor

To reduce the DANGER of the OPERATOR touching the HAZARDOUS LIVE conductor during clamping or measurement, Type A current sensors shall have a PROTECTIVE BARRIER or tactile indicator to warn the OPERATOR of the limit of safe access. The tactile indicator shall cover at least 50 % of the perimeter, and shall at least extend along two opposite sides of the HAND-HELD part.

The CLEARANCE and CREEPAGE DISTANCE between HAZARDOUS LIVE parts and the PROTECTIVE BARRIER or the tactile indicator shall meet the requirements for REINFORCED INSULATION for the RATING of the JAWS. Figure 103 gives an example of the CLEARANCE "*d*" from the PROTECTIVE BARRIER or tactile indicator to the JAWS and to the HAZARDOUS LIVE conductor.

Conformity is checked by inspection and measurement of CLEARANCES and CREEPAGE DISTANCES.



Key

1 HAZARDOUS LIVE conductor

2 PROTECTIVE BARRIER

d Distance between PROTECTIVE BARRIER and HAZARDOUS LIVE conductor

Figure 103 – CLEARANCE between the PROTECTIVE BARRIER or tactile indicator to the JAWS and to the HAZARDOUS LIVE conductor

6.9.101.3 HAND-HELD or hand-manipulated parts

HAND-HELD or hand-manipulated parts of Type A current sensors shall be separated by DOUBLE INSULATION or REINFORCED INSULATION from the parts of the JAWS which can be touched by a metal test pin 100 mm long and 4 mm in diameter, in open and in closed position. If any conductive part of the magnetic circuit can touch a conductor, it is considered to be held at the RATED voltage to earth of the JAWS.

NOTE The metal test pin simulates an UNINSULATED conductor.

If the wear indicator of a JAW END becomes visible during the pre-treatment, BASIC INSULATION is required for the JAW END after the pre-treatment.

Conformity is checked by inspection, by the determination of ACCESSIBLE parts according to 6.2, by measurement of CLEARANCES and CREEPAGE DISTANCES and by the tests of K.101.4 for solid insulation. If the JAW ENDS include a wear indicator, measurement and tests are done both before and after the pre-treatment of the JAW ENDS specified in 6.9.101.1, if applicable. If the JAW ENDS do not include a wear indicator, measurement and tests are performed after the pre-treatment.

~~**6.9.101.4 Insulation of flexible current sensors**~~

~~Flexible cord used for the JAW of a flexible current sensor which has a wear indicator shall provide at least DOUBLE INSULATION or REINFORCED INSULATION when new, and at least BASIC INSULATION when the wear indicator is visible.~~

~~If the flexible cord has a wear indicator, it shall exhibit a contrasting colour when the limit of wear is reached.~~

~~Flexible cord used for the JAW of a flexible current sensor which does not have a wear indicator shall provide at least DOUBLE INSULATION or REINFORCED INSULATION when new and after typical lifetime wear.~~

~~*Conformity is checked by the following tests:*~~

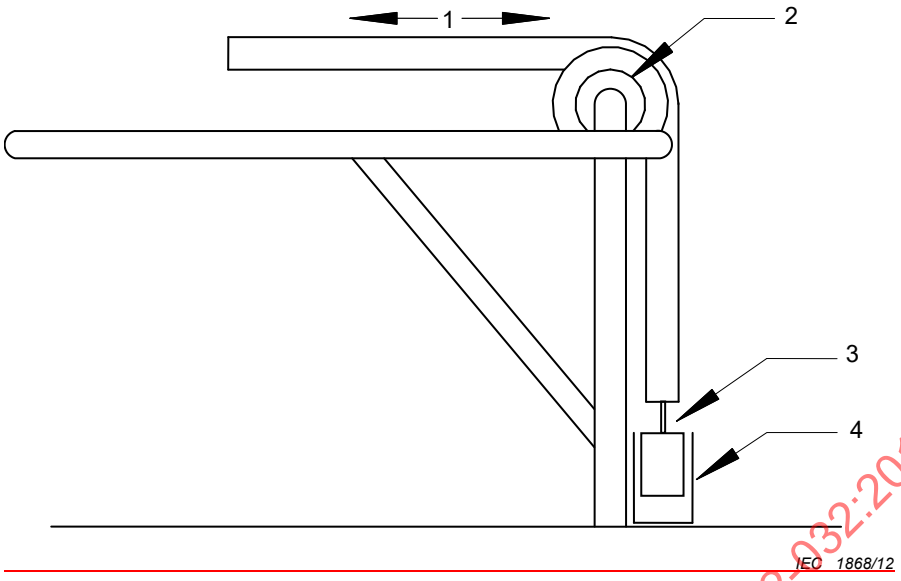
~~*Three unconditioned samples of the flexible cord used for the JAW of the flexible current sensor and three samples conditioned as specified in 10.5.2 a) are tested. Each sample is 1 m long.*~~

~~*One unconditioned sample is checked as specified by K.101.4, with the values for REINFORCED INSULATION.*~~

~~*Each sample is passed over a piece of emery cloth mounted to and conforming with the pulley radius of curvature (see Figure 105), with the pulley fixed so that it cannot rotate (see Figure 104). The internal pulley diameter and the pulley radius of curvature are at least 5 times the cord diameter. The emery cloth shall be No. 120 grit, with aluminium oxide abrasive bound in an enclosed coating and a cloth backing. It shall be of sufficient length and width so that the sample makes contact with the emery cloth wherever it would otherwise contact the pulley surface. The emery cloth is replaced after each sample is treated. To prevent rolling of the flexible cord, the inside surface of the pulley is concave.*~~

~~*The flexible cord is placed over the pulley (see Figure 104) and supported by a 90° arc of the pulley. One end of the flexible cord is attached to a weight with a mass of 1 kg. The flexible cord is positioned so that its midpoint is at the centre of the emery cloth at the middle of the cycle. With the weight guided to prevent swinging, the flexible cord is passed over the emery cloth surface for the lesser of 15 cycles or until a wear indicator becomes visible – one cycle consisting of one forward and one reverse movement of the free end of the cord for a distance of 0,5 m.*~~

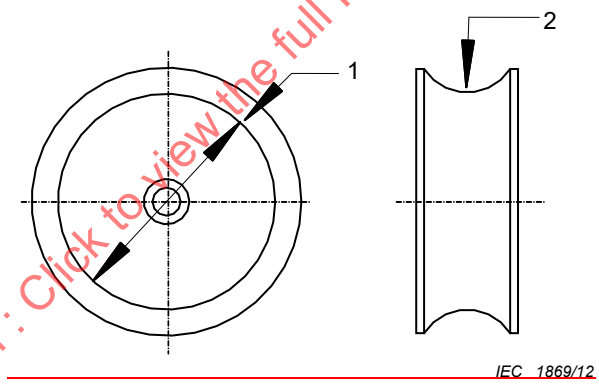
~~*After this treatment, each sample is checked as specified by K.101.4. The voltage is applied between the internal conductors of the flexible cord and metal foil wrapped around the outer cord jacket. The BASIC INSULATION test voltage values are used if the cycling treatment was terminated because the contrasting colour became visible. The REINFORCED INSULATION test voltage values are used if 15 cycles were completed during the cycling treatment without the wear indicator becoming visible.*~~



Key

1 Flexible cord
2 Fixed pulley
3 Weight
4 Weight guide

Figure 104 – Treatment of the insulation of a flexible current sensor



Key

1 Internal pulley diameter
2 Pulley radius of curvature

Figure 105 – Pulley for the treatment of Figure 104

6.9.101.5 Pull test for endcaps of flexible current sensors

The endcaps of a flexible cord used for the JAW of the flexible current sensor shall be securely fixed, so that they withstand any forces likely to occur in NORMAL USE.

Conformity is checked by inspection and the following test on each endcap.

With the endcap clamped so that it cannot move, the flexible cord is subjected to a steady axial pull force according to Table 102 for 1 min.

After the pull the insulation shall not have moved more than 2 mm.

If the insulation has moved more than 2 mm, then the pull is repeated 15 more times with a duration of 15 s each.

After the last pull:

a) the insulation shall not have moved more than 1 mm more than the displacement from the first pull if it is subjected to 16 pulls;

b) CLEARANCES and CREEPAGE DISTANCES shall not have been reduced below the applicable values of K.101 for REINFORCED INSULATION; and

c) the current sensor shall pass the tests of K.101.4 for REINFORCED INSULATION.

Table 102 – Pull forces for endcaps of flexible current sensors

Cross section area of the flexible cord mm^2	Pull force N
≤ 25 100 ≥ 500	50 75 100
Linear interpolation is allowed.	

6.9.102 Input measuring circuit leads

Input measuring circuit leads and their accessories shall meet the requirements of IEC 61010-031, if applicable.

Conformity is checked by inspection.

6.9.103 Output circuit leads

The output circuit leads of current sensors can easily touch HAZARDOUS LIVE parts of the installation under test. The output circuits of current sensors can also be held at a HAZARDOUS LIVE voltage when connected to a wattmeter, power quality analyser or similar equipment.

The output circuit leads of current sensors shall have REINFORCED INSULATION between their outer surfaces and their conductors.

The mated connectors and TERMINALS located at the current sensor ENCLOSURE body shall have REINFORCED INSULATION between their outer surfaces and their conductors.

For Type A, Type B and Type C current sensors, the insulation of the output circuit leads, and of the mated connectors and TERMINALS is based on the requirements of K.101 for the higher of the voltage RATING and the MEASUREMENT CATEGORY RATING of the JAWS or those RATINGS of the output circuit but not less than 300 V in MEASUREMENT CATEGORY II.

For Type D current sensors, the insulation of the output circuit leads and of the mated connectors and TERMINALS is based on the requirements of K.101 for 300 V in MEASUREMENT CATEGORY II.

Conformity is checked by inspection, by measurement of CLEARANCES and CREEPAGE DISTANCES and by the applicable tests of K.101.4 for solid insulation.

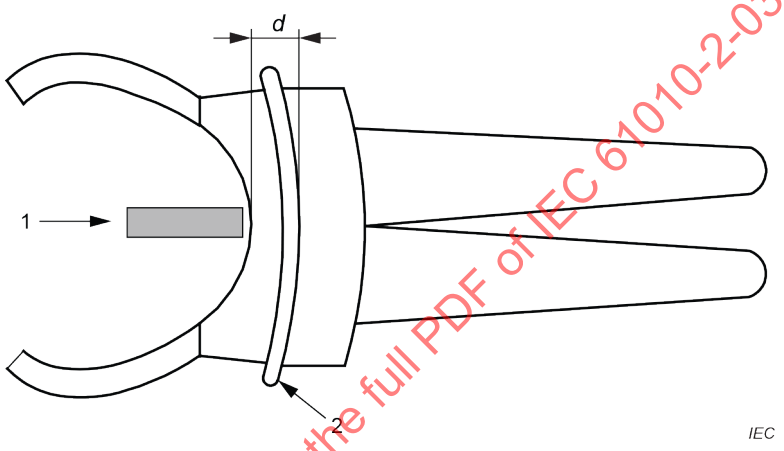
6.9.101 Protection against the HAZARDOUS LIVE conductor

6.9.101.1 Protection by a PROTECTIVE BARRIER

To reduce the RISK of the OPERATOR touching the HAZARDOUS LIVE conductor during clamping or measurement, Type A current sensors shall have a PROTECTIVE BARRIER to warn the OPERATOR of the limit of safe access. The PROTECTIVE BARRIER shall cover at least 50 % of the perimeter, and shall at least extend along two opposite sides of the HAND-HELD part.

The CLEARANCE and CREEPAGE DISTANCE between HAZARDOUS LIVE parts and the PROTECTIVE BARRIER shall meet the requirements for REINFORCED INSULATION for the RATING of the JAWS. Figure 102 gives an example of the CLEARANCE "*d*" from the PROTECTIVE BARRIER to the JAWS and to the HAZARDOUS LIVE conductor.

Conformity is checked by inspection and measurement of CLEARANCES and CREEPAGE DISTANCES.



Key

1 HAZARDOUS LIVE conductor

2 PROTECTIVE BARRIER

d Distance between PROTECTIVE BARRIER and HAZARDOUS LIVE conductor

Figure 102 – CLEARANCE between the PROTECTIVE BARRIER to the JAWS and to the HAZARDOUS LIVE conductor

6.9.101.2 HAND-HELD or hand-manipulated parts

HAND-HELD or hand-manipulated parts of Type A current sensors shall be separated by DOUBLE INSULATION or REINFORCED INSULATION from the parts of the JAWS which can be touched by an UNINSULATED CONDUCTOR, in open and in closed position. If any conductive part of the magnetic circuit can touch a conductor, it is considered to be held at the RATED voltage to earth of the JAWS.

JAW ENDS which have a wear indicator shall provide at least DOUBLE INSULATION or REINFORCED INSULATION when new, and at least BASIC INSULATION when the wear indicator becomes visible.

Conformity is checked by inspection, by determination of the touchable parts of the JAWS in open and in closed position using the metal pin of 6.2.3 and determination of the ACCESSIBLE HAND-HELD or hand-manipulated parts, and,

a) if the current sensor is RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.101.2 and K.101.3, and for solid insulation by the applicable tests of K.101.4;

b) if the current sensor is not RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.3.2 or K.3.3 and K.3.4, and for solid insulation by the applicable tests of K.3.5.

NOTE The metal test pin simulates an UNINSULATED CONDUCTOR.

In addition to the metal pin, the outer surfaces of the ENCLOSURE of the JAWS are covered with metal foil in open and in closed position during the test.

If the JAW ENDS of Type A current sensors RATED for MEASUREMENT CATEGORIES III and IV, include a wear indicator, measurement and tests are done both before and after the JAW ENDS abrasion test of 8.101 and the JAW impact test of 8.102, if applicable.

If the JAW ENDS do not include a wear indicator, measurement and tests are done after the JAW ENDS abrasion test of 8.101 and the JAW impact test of 8.102, if applicable.

6.9.102 Input/output circuits

Input/output circuits of Type A, Type B and Type C current sensors shall be separated by DOUBLE INSULATION or REINFORCED INSULATION from the parts of the JAWS which can be touched by an UNINSULATED CONDUCTOR, in open and in closed position. If any conductive part of the magnetic circuit can touch a conductor, it is considered to be held at the RATED voltage to earth of the JAWS.

JAW ENDS which have a wear indicator shall provide at least DOUBLE INSULATION or REINFORCED INSULATION when new, and at least BASIC INSULATION when the wear indicator becomes visible.

Conformity is checked by inspection, by determination of the touchable parts of the JAWS in open and in closed position using the metal pin of 6.2.3, and,

a) if the current sensor is RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.101.2 and K.101.3, and for solid insulation by the applicable tests of K.101.4;

b) if the current sensor is not RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.3.2 or K.3.3 and K.3.4, and for solid insulation by the applicable tests of K.3.5.

NOTE The metal test pin simulates an UNINSULATED CONDUCTOR.

In addition to the metal pin, the outer surfaces of the ENCLOSURE of the JAWS are covered with metal foil in open and in closed position.

If the JAW ENDS include a wear indicator, measurement and tests are done both before and after the JAW ENDS abrasion test of 8.101 and the JAW impact test of 8.102, if applicable.

If the JAW ENDS do not include a wear indicator, measurement and tests are done after the JAW ENDS abrasion test of 8.101 and the JAW impact test of 8.102, if applicable.

Add the following new subclause:

6.101 Output circuit leads

6.101.1 General

The outer surfaces of output circuit leads of current sensors can easily touch HAZARDOUS LIVE parts of the installation under test. The inner conductors of output circuit leads of current sensors can also be held at a HAZARDOUS LIVE voltage when connected to measuring or control equipment (wattmeter, power quality analyser, etc.).

6.101.2 Connection to the current sensor ENCLOSURE body

The mated TERMINALS located at the current sensor ENCLOSURE body and/or the leads shall have DOUBLE INSULATION or REINFORCED INSULATION between their outer surfaces and their conductors.

For Type A, Type B and Type C current sensors, the insulation of the output circuit leads and the mated TERMINALS is based on the requirements of Clause K.101 for the higher of the voltage RATING and the MEASUREMENT CATEGORY RATING of the JAWS or this RATING of the output circuit but not less than 300 V in MEASUREMENT CATEGORY II.

For Type D current sensors, the insulation of the output circuit leads and of the mated TERMINALS is based on the requirements of Clause K.101 for 300 V in MEASUREMENT CATEGORY II.

Conformity is checked by inspection, by measurement of the applicable values of CLEARANCES and CREEPAGE DISTANCES of K.101.2 and by the applicable tests of K.101.4 for solid insulation.

6.101.3 Connection to measuring or control equipment

The manufacturer shall assign a voltage value and specify if a MEASUREMENT CATEGORY is RATED for this connection.

No minimum voltage RATINGS are required by this document for the current sensor TERMINALS dedicated for connection to measuring or control equipment.

The unmated TERMINALS shall comply with the requirements of 101.2.

If the current sensor has been designed for use only with a specific model of equipment, the current sensor TERMINAL RATING shall be consistent with the TERMINAL RATING of this specific measuring or control equipment.

Conformity is checked as specified in 101.2, by inspection, and,

a) if the current sensor is RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.101.2 and K.101.3, and for solid insulation by the applicable tests of K.101.4;

b) if the current sensor is not RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.3.2 or K.3.3 and K.3.4, and for solid insulation by the applicable tests of K.3.5.

7 Protection against mechanical HAZARDS

This clause of Part 1 is applicable.

8 Resistance to mechanical stresses

This clause of Part 1 is applicable except as follows:

~~**8.1 General**~~

~~*Addition:*~~

~~*Add the following new item 101), after item 3):*~~

~~*101) for Type A current sensors RATED for MEASUREMENT CATEGORIES III and IV, the impact test of 8.2.101.*~~

~~**8.2 ENCLOSURE rigidity tests**~~

~~*Addition:*~~

~~*Add the following new subclause:*~~

~~**8.2.101 JAW impact test**~~

~~*The test is carried out on three samples of Type A current sensors RATED for MEASUREMENT CATEGORIES III and IV.*~~

~~*The current sensor is tested according to IEC 60068-2-75 by either test Eha (pendulum hammer) or test Ehc (vertical hammer) with an energy level of Table 103.*~~

~~**Table 103 – Energy level**~~

~~Current sensor mass kg~~	~~Energy level J~~	~~IK Code (IEC 62262)~~
~~≤ 0,5~~	~~1~~	~~IK06~~
~~> 0,5 ≤ 1~~	~~2~~	~~IK07~~
~~> 1~~	~~5~~	~~IK08~~

~~*Current sensors are cooled to the minimum RATED ambient temperature, and then tested within 3 min. The current sensor is held firmly against a rigid support and opened as far as possible. Three points on the outer surfaces of the JAWS close to the JAW ENDS are tested on each sample. The number of impacts is one per point.*~~

~~*After the impact test, the current sensors are returned to a reference test temperature (see 4.3.1). For each voltage of Table 105 up to and including the highest RATED voltage of the JAWS, the specified test probe of Figure 106 and Table 105 is inserted into the JAW opening as shown in Figure 107. While each test probe is inserted, the current sensor shall pass the a.c. voltage test of 6.8.3.1 (without humidity preconditioning) with a duration of at least 1 min, or for current sensors RATED only for d.c., the 1 min d.c. voltage test of 6.8.3.2 (without humidity preconditioning), using the applicable test voltage of Table 105 applied between the test lead wires.*~~

Add the following four new subclauses:

8.101 JAW ENDS abrasion test

When current sensors are applied to or removed from conductors, their JAW ENDS can be submitted to abrasion, in particular when the conductor is a busbar. These current sensors shall be designed to be safe after the following JAW ENDS abrasion test, performed to simulate the wear of the JAWS during insertion and removal. This requirement is applicable only to Type A and Type B current sensors RATED for MEASUREMENT CATEGORIES III and IV. Current sensors with a sliding JAW, current sensors with fork-style JAWS and flexible current sensors are not concerned by 8.101.

JAW ENDS can have a wear indicator to view the limit of use after abrasion. A wear indicator is a feature with a contrasting colour designed to be not visible until a limit has been reached.

One unconditioned sample of the current sensor in NORMAL CONDITION and one preconditioned sample of the current sensor that has been conditioned as specified in 10.5.2 a) are treated as follows.

A plate is prepared consisting of a rigid material, covered on both sides by emery cloth. The plate is a minimum of 50 mm by 450 mm, with a thickness not exceeding 2 mm. The emery cloth shall be No. 120 grit, with aluminium oxide abrasive bound in an enclosed coating and with a cloth backing.

With the JAWS open, the samples are positioned as shown in Figure 103 and then the JAWS are closed.

The samples are moved along the plate over a distance of 200 mm, or a lesser amount if restricted by the design, for 50 cycles – one cycle consisting of one forward and one reverse movement – so as to abrade the closing point of the JAWS (see Figure 103). If the insulation of the JAW ENDS has a wear indicator, the test is terminated if the wear indicator becomes visible before 50 cycles are completed. The emery cloth is replaced after each sample has been treated.

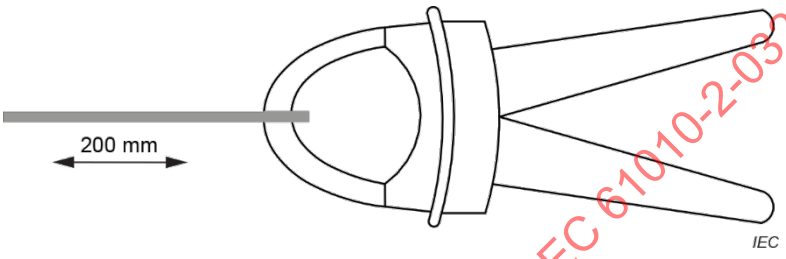


Figure 103 – Abrasion test of the JAW ENDS

After the abrasion test, the samples of current sensor are submitted to the conformity statement of 6.9.101.2 and 6.9.102.

8.102 Jaw impact test

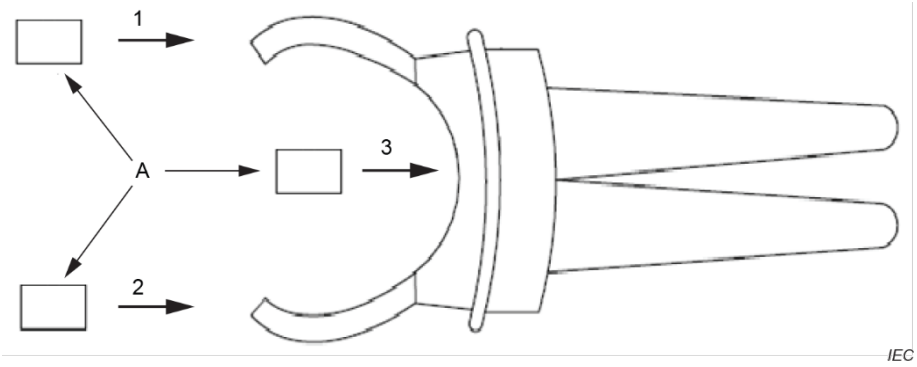
When current sensors are applied to or removed from conductors, they can hit them and be damaged, in particular when the conductor is a busbar. These current sensors shall be designed to be safe after the following JAW impact test, performed to simulate the stress of the JAWS during insertion. This requirement is applicable only to Type A current sensors RATED for MEASUREMENT CATEGORIES III and IV, except for flexible current sensors. The normal energy protection level required for impact is from Table 102.

The test is carried out on one sample of current sensor. The sample is tested according to IEC 60068-2-75 either by Eha (pendulum hammer) test, Ehb (spring hammer) test or Ehc (vertical hammer) test with an energy level determined from Table 102 according to the current sensor mass.

Table 102 – Energy level for JAW impact test

Current sensor mass kg	Energy level J	IK code (IEC 62262)
≤ 0,5	1	IK06
> 0,5 ≤ 1	2	IK07
> 1	5	IK08

The sample is cooled to the minimum RATED ambient temperature for at least 4 h, and then tested within 3 min. The sample is held firmly against a rigid support and opened as far as possible. Three points are tested, two of these are on the outer surfaces of the JAWS close to the JAW ENDS, and the third point is the inner surface of the sensor directly opposite the opening (see Figure 104). The number of impacts is one per point.



Key

A Hammer

1, 2, 3 Direction of impact

Figure 104 – Impact points for JAW impact test

After the JAW impact test, the sample of current sensor is returned to a reference test temperature (see 4.3.1) and submitted to the conformity statement of 6.9.101.2 and 6.9.102.

8.103 Pressure test at high temperature for insulation of flexible current sensors

Flexible cords used for the JAW of a flexible current sensor shall not cause a HAZARD when subjected to mechanical stress likely to occur in NORMAL USE. To achieve this requirement, flexible cords shall be designed to be safe after the following pressure test, performed to simulate the stress of the flexible cords during use.

Flexible cords can have a wear indicator to view the limit of use. A wear indicator is a feature with a contrasting colour designed to be not visible until a limit of wear has been reached.

Flexible cords shall provide at least DOUBLE INSULATION or REINFORCED INSULATION when new. In addition, they shall meet the following:

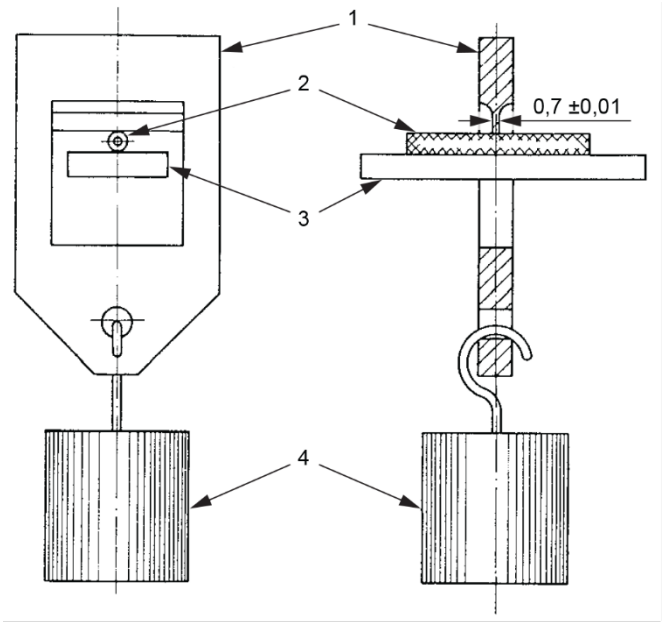
a) If they do not have a wear indicator, they shall provide at least DOUBLE INSULATION or REINFORCED INSULATION after typical lifetime wear.

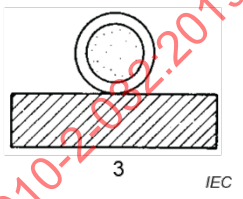
b) If they have a wear indicator, they shall provide at least BASIC INSULATION when the wear indicator becomes visible.

Conformity is checked by the following tests:

Three samples of the flexible cord are tested. Each sample is taken from a flexible current sensor having a length of 150 mm to 300 mm. The length of each sample is 50 mm to 100 mm.

The indentation device is shown in Figure 105, and consists of a rectangular blade with an edge 0,70 mm ± 0,01 mm wide, which can be pressed against the sample. Each sample is placed in the position shown in Figure 105. A flat flexible cord without a sheath is laid on its flat side. Samples are fixed on the support in such a manner that they do not curve under the pressure of the blade. The force is applied in a direction perpendicular to the axis of the sample; the blade is also perpendicular to the axis of the sample.





Key

1 Testing frame

2 Sample

3 Supports

4 Weight

Figure 105 – Indentation device

The compressing force F which is exerted by the blade upon the sample is given by the formula:

$$F = 0,6 \times \sqrt{(2 \times d \times e - e^2)}$$

where:

F is in newtons

e is the mean value of the thickness of the insulation of the sample

d is the mean value of the outer diameter of the sample

e and d are both expressed in millimetres, to one decimal place, and measured on a thin slice cut from the end of the test piece.

The test is carried out in air (i.e. in an air oven). The temperature of the air is maintained continuously at a temperature of minimum 105 °C. The loaded samples are kept in the test position for 4 h. Following this, the samples are rapidly cooled; cooling may be carried out by spraying the samples with cold water on the spot where the blade is pressing. The samples are removed from the apparatus when they have cooled to a temperature where recovery of the insulation no longer occurs. The samples are then cooled further by immersion in cold water.

After this treatment, each sample of flexible cord is checked as specified by the applicable tests of K.101.4 (without humidity preconditioning) if they are RATED for MEASUREMENT CATEGORIES, or by the applicable tests of K.3.5 (without humidity preconditioning) if they are not RATED for MEASUREMENT CATEGORIES.

The voltage is applied between the internal conductors of the flexible cord and metal foil wrapped around the outer cord jacket. The BASIC INSULATION test voltage values are used if the contrasting colour of the wear indicator is visible. Otherwise, the REINFORCED INSULATION test voltage values are used.

8.104 Pull test for endcaps of flexible current sensors

The endcaps of a flexible cord used for the JAW of the flexible current sensor shall be securely fixed, so that they withstand any forces likely to occur in NORMAL USE.

Conformity is checked by inspection and the following test on each endcap.

With the endcap clamped so that it cannot move, the flexible cord is subjected to a steady axial pull force according to Table 103 for 1 min. After the pull, the insulation shall not have moved more than 2 mm. If the insulation has moved more than 2 mm, then the pull is repeated 15 more times with a duration of 15 s each time.

After the last pull:

a) the insulation shall not have moved more than 1 mm above the displacement from the first pull if it is subjected to 16 pulls;

b) CLEARANCES and CREEPAGE DISTANCES shall not have been reduced below the applicable values for REINFORCED INSULATION defined in K.101.2 *and* K.101.3 *if the current sensor is RATED for MEASUREMENT CATEGORIES, or shall not have been reduced below the applicable values given in K.3.2 or K.3.3 and K.3.4 if the current sensor is not RATED for MEASUREMENT CATEGORIES; and*

c) the current sensor shall pass the applicable tests for REINFORCED INSULATION defined in K.101.4 *(without humidity preconditioning) if it is RATED for MEASUREMENT CATEGORIES, or the applicable tests of K.3.5 (without humidity preconditioning) if it is not RATED for MEASUREMENT CATEGORIES.*

Table 103 – Pull forces for endcaps of flexible current sensors

Maximum diameter of the flexible cord mm	Pull force N
≤ 5	50
10	75
≥ 20	100
Linear interpolation is allowed.	

9 Protection against the spread of fire

This clause of Part 1 is applicable.

10 Equipment temperature limits and resistance to heat

This clause of Part 1 is applicable except as follows:

10.5 Resistance to heat

Add the following new subclause:

10.5.101 Resistance to heat of current sensors

The insulating material of JAWS surrounding a magnetic material which can overheat shall have adequate resistance to heat.

Conformity is checked by examination of material data. For rigid insulating materials, if the material data is not conclusive, one of the following tests is performed.

a) A sample of the insulating material, at least 2,5 mm thick, is subjected to a ball-pressure test using the test apparatus in Figure 14. The test is made in a heating cabinet at the temperature measured as specified in 10.101 ± 2 °C, or at 105 °C ± 2 °C, whichever is higher. The part to be tested is supported so that its upper surface is horizontal, and the spherical part of the apparatus is pressed against this surface with a force of 20 N. After 1 h the apparatus is removed and the sample is cooled within 10 s to approximately room temperature by immersion in cold water. The diameter of the impression caused by the ball shall not exceed 2 mm.

NOTE 1 If necessary, the required thickness can be obtained by using two or more sections of the part.

NOTE 2 See IEC 60695-10-2 for more information about this test.

b) The Vicat softening test of ISO 306, method A120. The Vicat softening temperature shall be at least 105 °C.

Add the following new subclause:

10.101 Other temperatures of current sensors

Most current sensors depend on inductive connection to the circuit being measured. The behaviour of the measuring circuit will, in these cases, depend on the frequency of the signal being measured. When the current sensor is used to measure currents at high frequency, circulating currents could cause significant heating within the magnetic circuit of the current sensor.

If a HAZARD could be caused by excessive temperature, easily touched surfaces shall not exceed the values of Table 19 and the temperature of the insulating material of windings shall not exceed the values of Table 20 when the current sensor measures the maximum current at the frequency which causes the highest temperature.

NOTE The PROTECTIVE BARRIER of the current sensor (see 6.9.101.~~2~~1) is not considered to provide a protection against burns.

Conformity is checked by measurement as specified in 10.4.

11 Protection against HAZARDS from fluids and solid foreign objects

This clause of Part 1 is applicable.

12 Protection against radiation, including laser sources, and against sonic and ultrasonic pressure

This clause of Part 1 is applicable.

13 Protection against liberated gases and substances, explosion and implosion

This clause of Part 1 is applicable.

14 Components and subassemblies

This clause of Part 1 is applicable except as follows:

Add the following two new subclauses:

14.101 Circuits ~~or components~~ used ~~as~~ to limit TRANSIENT OVERVOLTAGE ~~limiting devices~~ in measuring circuits used to measure MAINS

If control of TRANSIENT OVERVOLTAGES ~~are limited~~ is employed in a measuring circuit used to measure MAINS, the overvoltage limiting ~~device~~ component or circuit shall have adequate strength to limit likely TRANSIENT OVERVOLTAGES ~~in NORMAL USE~~.

Conformity is checked by applying five positive and five negative impulses with the applicable impulse voltage of Table 104, spaced up to 1 min apart, from a hybrid impulse generator (see IEC 61180~~-1~~). The generator produces an open-circuit voltage waveform of 1,2/50 μs, a short-circuit current waveform of 8/20 μs, with an output impedance (peak open-circuit voltage divided by peak short-circuit current) of 2 Ω for MEASUREMENT CATEGORIES III and IV or 12 Ω for MEASUREMENT CATEGORY II. Resistance may be added in series if needed to raise the impedance. ~~The test impulse is applied in combination with the MAINS voltage. The MAINS voltage is the highest RATED voltage of the measuring circuit TERMINALS, but no more than 400 V a.c. r.m.s.~~

The test voltage is applied while the circuit is operating under conditions of NORMAL USE, in combination with the MAINS voltage between each pair of TERMINALS used to measure MAINS where voltage-limiting devices are present.

The MAINS voltage is the maximum RATED line-to-neutral voltage of the MAINS being measured. For measuring circuits RATED for MAINS line-to-neutral voltages above 400 V a.c. r.m.s. or d.c., the test may be performed with an available voltage source that has a line-to-neutral voltage of at least 400 V a.c. r.m.s. or d.c. The voltage source does not, in this case, need to match the measuring circuit RATING, but circuits RATED for a.c. shall be tested with an a.c. source, and circuits RATED for d.c. shall be tested with a d.c. source.

NOTE 1 The impulses are synchronized with the MAINS voltage phase, timed to occur at the peak of the MAINS voltage and to be of the same polarity, with a phase tolerance of ±10° (see IEC 61180).

NOTE 2 This test can be extremely hazardous. Explosion shields and other provisions can be used to protect personnel performing the test.

No HAZARD shall arise ~~in the event that the component ruptures or overheats during the test. If a rupture occurs, no part of the component shall bridge safety-relevant insulation. If the component overheats, it shall not heat other materials to their self-ignition points.~~ The overvoltage limiting devices shall not rupture or overheat during the test. Tripping the circuit breaker of the MAINS installation is an indication of failure. If the results of the test are questionable or inconclusive, the test is to be repeated two more times.

Table 104 – Impulse voltages

Nominal a.c. r.m.s line-to-neutral or d.c. voltage of MAINS being measured V	Impulse ~~withstand~~ voltage V peak		
	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV
≤ 50	500	800	1 500
>50 ≤ 100	800	1 500	2 500
> 100 ≤ 150	1 500	2 500	4 000
> 150 ≤ 300	2 500	4 000	6 000
> 300 ≤ 600	4 000	6 000	8 000
> 600 ≤ 1 000	6 000	8 000	12 000
> 1 000 ≤ 1 500	8 000	10 000	15 000
>1 500 ≤ 2 000	12 000	15 000	18 000
>2 000 ≤ 3 000	15 000	18 000	20 000
Values over 1 000 V are from IEC TS 62993:2017, Table 1.			

14.102 Probe assemblies and accessories

Probe assemblies and accessories within the scope of IEC 61010-031, shall meet the requirements thereof.

Conformity is checked by inspection.

15 Protection by interlocks

This clause of Part 1 is applicable.

16 HAZARDS resulting from application

This clause of Part 1 is applicable ~~except as follows:~~

~~*Addition:*~~

~~*Add the following new subclause:*~~

~~**16.101 Reliance on the displayed value**~~

~~**16.101.1 Over-range indication**~~

~~If a HAZARD could arise from an OPERATOR'S reliance on the value displayed by the equipment, the display shall give an unambiguous indication whenever the value is above the maximum positive value or below the minimum negative value of the range to which the equipment is set.~~

~~NOTE Examples of ambiguous indications include the following, unless there is a separate unambiguous indication of an over-range value:~~

~~a) analogue METERS with stops at the exact ends of the range;~~

~~b) digital METERS which show a low value when the true value is above the range maximum (for example 1 001,5 A displayed as 001,5 A).~~

~~*Conformity is checked by inspection and by provoking an over-range condition.*~~

~~**16.101.2 Low battery indication**~~

~~When the battery of a current sensor which is powered by an internal battery, discharges, no HAZARD shall arise from an OPERATOR's reliance on a value displayed by the current sensor, at every battery voltage or energy level.~~

~~Conformity is checked by inspection and, in case of doubt, by provoking a battery discharge~~.

17 RISK assessment

This clause of Part 1 is applicable.

Add the following new Clauses 101 and 102:

101 Measuring circuits

101.1 General

The ~~equipment~~ current sensor shall provide protection against HAZARDS resulting from NORMAL USE and REASONABLY FORESEEABLE MISUSE of measuring circuits, as specified below.

a) If a HAZARD could result, a current measuring circuit shall not interrupt the circuit being measured during range changing, or during the use of current sensors with an internal current transformer (see 101.2).

b) An electrical quantity that is within specification for any TERMINAL shall not cause a HAZARD when it is applied to that TERMINAL or to any other compatible TERMINAL, with the range and function settings set in any possible manner (see 101.3).

c) Any interconnection between the ~~equipment~~ current sensor and other devices or accessories intended to be used with the ~~equipment~~ current sensor shall not cause a HAZARD even if the documentation or markings prohibit the interconnection while the ~~equipment~~ current sensor is used for measurement purposes (see 6.6).

d) A TEMPORARY OVERVOLTAGE or a TRANSIENT OVERVOLTAGE applied on the measuring circuits' TERMINALS in a voltage measurement function shall not cause a HAZARD (see 101.4).

e) Other HAZARDS that could result from REASONABLY FORESEEABLE MISUSE shall be addressed by RISK assessment (see Clauses 16 and 17).

Conformity is checked as specified in 6.6, Clause 16, Clause 17, 101.2, 101.3 and 101.4, as applicable.

101.2 Current sensor with an internal current transformer

If a high voltage could be generated by an open-circuit condition of the output circuit, any voltage above the levels of 6.3.2 shall not be ACCESSIBLE.

Conformity is checked by inspection of the output circuit TERMINALS or connector and, in case of doubt, by measurement of the output circuit voltage when the output circuit is interrupted while the current sensor is operating at the RATED current of the JAWS. The output circuit voltage is measured as specified in 6.3.2.

101.3 Protection against mismatches of inputs and ranges

101.3.1 General

In NORMAL CONDITION and in cases of REASONABLY FORESEEABLE MISUSE, no HAZARD shall arise when the highest RATED voltage or current of a measuring circuit TERMINAL is applied to that TERMINAL or to any other compatible TERMINAL, with any combination of function and range settings.

NOTE Mismatches of inputs and ranges are examples of REASONABLY FORESEEABLE MISUSE, even if the documentation or markings prohibit such mismatch. A typical example is inadvertent connection of a high voltage to a measuring input intended for current or resistance. Possible HAZARDS include electric shock, burns, fire, arcing and explosion.

TERMINALS that are clearly not of similar types and that will not retain the connectors of the probe or accessory do not need to be tested and TERMINALS that can only be accessed by use of a TOOL do not need to meet the requirement of 101.3.1.

The ~~equipment~~ current sensor shall provide protection against these HAZARDS. One of the following techniques shall be used.

a) Use of a certified overcurrent protection device to interrupt short-circuit currents before a HAZARD arises. In this case, the requirements and test of 101.3.2 apply.

b) Use of an uncertified current limitation device, an impedance, or a combination of both to prevent the HAZARD from arising. In this case, the requirements and tests of 101.3.3 apply.

Conformity is checked by inspection, evaluation of the design of the ~~equipment~~ current sensor, and as specified in 101.3.2 and 101.3.3, as applicable.

~~*These tests shall be performed with any probe assemblies supplied by the manufacturer, and repeated with the test leads of 101.3.4.*~~

101.3.2 Protection by a certified overcurrent protection device

An overcurrent protection device is considered suitable if it is certified by an independent laboratory ~~to meet~~ and if all of the following requirements are met.

a) The a.c. and d.c. RATED voltages of the overcurrent protection device shall be at least as high as, respectively, the highest a.c. and d.c. RATED voltages of any measuring circuit TERMINAL on the ~~equipment~~ current sensor.

b) The RATED time-current characteristic (speed) of the overcurrent protection device shall be such that no HAZARD will result from any possible combination of RATED input voltages, TERMINALS, and range selection.

NOTE In practice, downstream circuit elements such as components and printed wiring board traces are selected to be able to withstand the energy that the overcurrent protection device will let through.

c) The a.c. and d.c. RATED breaking capacities of the overcurrent protection device shall exceed, respectively, the possible a.c. and d.c. short-circuit currents.

The possible a.c. and d.c. short-circuit currents shall be calculated as the highest RATED voltages for any TERMINAL divided by the impedance of the overcurrent-protected measuring circuit, taking the impedance of the test leads specified in 101.3.4 into account.

For MEASUREMENT CATEGORIES II and III, the possible a.c. short-circuit current does not need ~~not~~ to exceed the applicable values of Table AA.1.

Additionally, spacings surrounding the overcurrent protection device in the ~~equipment~~ current sensor and following the protection device in the measuring circuit shall be sufficiently large to prevent arcing after the protection device opens.

Conformity is checked by inspection of the RATING~~S~~ of the overcurrent protection device and by the following test.

If the protection device is a fuse, it is replaced with an open-circuited fuse. If the protection device is a circuit-breaker, it is set to its open position. A voltage of two times the highest RATED voltage for any TERMINAL is applied to the TERMINALS of the overcurrent-protected measuring circuit for 1 min. ~~The test equipment shall be able to supply a current of at least 100 mA a.c. r.m.s. for voltages below 5 kV and a power of 500 VA at and above 5 kV.~~ During and after the test, no damage to the ~~equipment~~ current sensor shall occur.

101.3.3 Protection by uncertified current limitation devices or by impedances

Devices used for current limitation shall be capable of safely withstanding, dissipating, or interrupting the energy that will ~~be applied as a result of short-circuit current~~ result from the application of the maximum RATED voltage of any compatible TERMINAL in NORMAL CONDITION and in the case of REASONABLY FORESEEABLE MISUSE.

An impedance used for limitation of current shall be one or more of the following.

a) An appropriate single component which is constructed, selected, and tested so that safety and reliability for protection against relevant HAZARDS ~~is~~ are assured. In particular, the component shall
   1) be RATED for the maximum voltage that may be present in NORMAL CONDITION or during the REASONABLY FORESEEABLE MISUSE event;
   2) if a resistor, be RATED for twice the power or energy dissipation that may result in NORMAL CONDITION or from the REASONABLY FORESEEABLE MISUSE event;
   3) meet the applicable CLEARANCE and CREEPAGE DISTANCE requirements of Annex K for ~~REINFORCED~~ BASIC INSULATION between its terminations.

b) A combination of components which shall:
   1) withstand the maximum voltage that may be present in NORMAL CONDITION or during the REASONABLY FORESEEABLE MISUSE event;
   2) be able to dissipate the power or energy that may result in NORMAL CONDITION or from the REASONABLY FORESEEABLE MISUSE event;
   3) meet the applicable CLEARANCE and CREEPAGE DISTANCE requirements of Annex K for ~~REINFORCED~~ BASIC INSULATION between the terminations of the combination of components.

   NOTE 1 The CLEARANCES and CREEPAGE DISTANCES take into account the WORKING VOLTAGE across each insulation.

Conformity is checked by inspection and the following test, ~~repeated~~ performed three times on the same unit of ~~equipment~~ current sensor. If the test results in heating of any component, the ~~equipment~~ current sensor is allowed to cool before the test is repeated. If a device used for current limitation is damaged, it is replaced before the test is repeated.

The possible a.c. and d.c. short-circuit currents are calculated as the highest RATED voltage for any TERMINAL divided by the impedance of the current-limited measuring circuit, taking the impedance of the test leads specified in 101.3.4 into account. For MEASUREMENT CATEGORIES II and III, the possible a.c. short-circuit current should not exceed the values in Table AA.1.

A voltage equal to the highest RATED voltage for any TERMINAL is applied between the TERMINALS of the measuring circuit for 1 min. The source of the test voltage shall be able to deliver a current of at least the possible a.c. or d.c. short-circuit current as applicable. If the function or range controls have any effect on the electrical characteristics of the input circuit, the test is repeated with the function or range controls in every combination of positions, including during the change of function or range. During the test, the voltage output of the source is measured. If the source voltage decreases by more than 20 % for more than 10 ms, the test is considered inconclusive and is repeated with a lower impedance source.

During and after the test, no HAZARD shall arise, nor shall there be any evidence of fire, arcing, explosion, or damage to ~~impedance~~ current limitation devices, impedances or any component intended to provide protection against electric shock, heat, arc or fire, including the ENCLOSURE and traces on the printed wiring board. ~~Any damage to a device used for current limitation shall be ignored if other parts of the equipment were not affected during the test.~~

~~*During the test, the voltage output of the source is measured. If the source voltage decreases by more than 20 % for more than 10 ms, the test is considered inconclusive and is repeated with a lower impedance source.*~~

NOTE 2 This test can be extremely hazardous. Explosion shields and other provisions can be used to protect personnel performing the test.

101.3.4 Test leads for the tests of 101.3.2 and 101.3.3

The tests of 101.3.2 and 101.3.3 shall be performed with ~~any~~ all test leads that are ~~included~~ specified or supplied by the manufacturer for use with the ~~equipment~~ current sensor and if the manufacturer has not specified the test leads, the tests shall be ~~repeated~~ performed with test leads that meet the following specifications:

a) length = 1,0 m;

b) cross section of the conductor = 1,5 mm², stranded copper wire;

NOTE ~~1~~ A conductor with a 16 AWG (American Wire Gauge) cross section is acceptable.

c) ~~equipment~~ connector compatible with the measuring circuit TERMINALS;

d) connection to the test voltage source via a bare wire into suitable screw TERMINALS or thimble connectors (twist-on wire connectors) or equivalent means of providing a low-impedance connection;

e) arranged as straight as possible.

~~NOTE 2~~ Test leads built to these specifications will have a d.c. resistance of about 15 mΩ each, or 30 mΩ per pair. For the purposes of calculation of possible fault current in 101.3.2 and 101.3.3, the value of 30 mΩ can be used for these test leads.

If the manufacturer-supplied test leads are permanently connected to the ~~equipment~~ current sensor, then the attached test leads supplied by the manufacturer shall be used without modification.

101.4 Protection against MAINS overvoltages

~~MAINS voltage measuring circuits shall be so designed that, when a TEMPORARY OVERVOLTAGE or a TRANSIENT OVERVOLTAGE is applied on the measuring circuits TERMINALS in voltage measurement function in the proper range, no damage shall result which could cause a HAZARD.~~

~~MAINS voltage measuring circuits shall have a minimum of BASIC INSULATION between MAINS-connected conductive parts of opposite polarity.~~

~~*Conformity is checked by inspection, and by the following impulse withstand voltage test using the applicable test voltage of Table 104, or by the impulse withstand voltage test of 14.101 if an overvoltage limiting component or circuit is used to control the TRANSIENT OVERVOLTAGE.*~~

~~*The test voltage is applied between each pair of TERMINALS used to measure MAINS voltage. The impulse withstand voltage test shall be conducted for five impulses of each polarity with an interval of at least 1 s between impulses. The impulse voltage test is carried out with a 1,2/50 µs waveform (see Figure 1 of IEC 61180-1:1992). The wave shape of each impulse shall be observed (see Note 1 below).*~~

To ensure protection against arc flash or fire, measuring circuits RATED for measuring MAINS voltages shall have minimum CLEARANCES and CREEPAGE DISTANCES equivalent to BASIC INSULATION between MAINS-connected conductive parts of opposite polarity.

Conformity is checked by inspection and measurement.

In addition, the measuring circuit TERMINALS of a voltage measuring circuit that are RATED for MEASUREMENT CATEGORIES III or IV shall withstand the applicable TRANSIENT OVERVOLTAGE with the voltage measurement function selectors set for the proper function and range, without damage which could cause a HAZARD.

Conformity is checked by the following impulse voltage test using the applicable impulse voltage of Table 104.

The impulse voltage is applied between each pair of TERMINALS RATED for MEASUREMENT CATEGORY III or IV. The impulse voltage test shall be conducted for five impulses of each polarity spaced up to 1 min apart, from a hybrid impulse generator (see IEC 61180). The generator produces an open-circuit voltage waveform of 1,2/50 μs, a short-circuit current waveform of 8/20 μs, with an output impedance (peak open-circuit voltage divided by peak short-circuit current) of 2 Ω for MEASUREMENT CATEGORIES III and IV. Resistance may be added in series if needed to raise the impedance.

The impulse voltage is applied while the circuit is working under conditions of NORMAL USE, in combination with the MAINS voltage.

The MAINS voltage used for the test is the maximum RATED line-to-neutral voltage of the MAINS being measured. For measuring circuits RATED for MAINS line-to-neutral voltages above 400 V a.c. r.m.s. or d.c., the test may be performed with an available MAINS voltage source that has a line-to-neutral voltage of at least 400 V a.c. r.m.s. or d.c. The MAINS voltage source does not, in this case, need to match the measuring circuit RATING, but circuits RATED for a.c. or a.c. plus d.c. shall be tested with an a.c. source, and circuits RATED for d.c. only shall be tested with a d.c. source.

NOTE 1 The impulses are synchronized with the MAINS voltage phase, timed to occur at the peak of the MAINS voltage, and to be of the same polarity, with a phase tolerance of ±10° (see IEC 61180).

NOTE 2 This test can be extremely hazardous. Explosion shields and other provisions can be used to protect personnel performing the test.

When verifying CLEARANCES within ~~equipment~~ the current sensor by an impulse voltage test, it is necessary to ensure that the specified impulse voltage appears at the CLEARANCE.

The wave shape of each impulse shall be observed (see Note 3). Distortions of the impulse voltage which do not change from impulse to impulse may be caused by operation of an overvoltage limiting device and do not indicate a (partial) breakdown of solid insulation.

No HAZARD shall arise. No flashover of CLEARANCES or breakdown of solid insulation shall occur during the test, but partial discharges are allowed. Partial discharge will be indicated by a step in the resulting wave shape which will occur earlier in successive impulses. Breakdown on the first impulse may either indicate a complete failure of the insulation system or the operation of overvoltage limiting devices in the ~~equipment~~ current sensors. If overvoltage limiting devices are present, they shall not rupture or overheat during the test. Tripping the circuit breaker of the MAINS installation is an indication of failure. If the results of the test are questionable or inconclusive, the test is to be repeated two more times.

~~NOTE 1 Distortions of the impulse voltage which do not change from impulse to impulse can be caused by operation of an overvoltage limiting device and do not indicate a (partial) breakdown of solid insulation.~~

NOTE ~~2~~ 3 Partial discharges in voids can lead to partial notches of extremely short durations in the wave shape which can be repeated in the course of an impulse.

102 Prevention of HAZARD from arc flash and short-circuits

102.1 General

When a current sensor temporarily bridges two high-energy conductors, it may cause a short-circuit, resulting in high current flow through the current sensor. The current sensor may

become hot, or may melt. This may cause burns to an OPERATOR or a bystander near the current sensor.

If contact is broken (by OPERATOR action, melting, or other event) while current is flowing through the current sensor, arcing may occur. The arcing will ionize the air in the vicinity of the arc, permitting continued current flow in the vicinity of the current sensor. If there is sufficient available energy, then the ionization of the air will continue to spread and the flow of current through the air continues to increase. The result is an arc flash, which is similar to an explosion, and can cause injury or death to an OPERATOR or a bystander.

The current sensor shall be constructed to mitigate the RISK of arc flash and short-circuits.

Conformity is checked as specified in 102.2 and 102.3. All measurements and tests of 102.2 and 102.3 are done after ~~the pre-treatment of~~ the JAW ENDS ~~specified in 6.9.101.1~~ abrasion test of 8.101, if applicable.

102.2 Protection against short-circuits during clamping

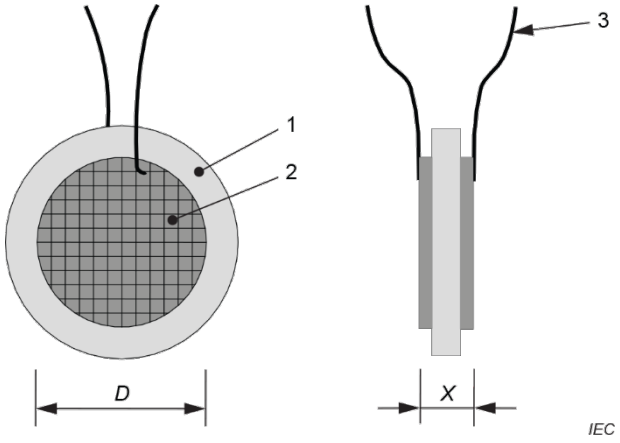
Type A and Type B current sensors shall have additional protection against a short-circuit caused by the JAWS during insertion and removal between conductors and between busbars. This requirement is not applicable to Type A current sensors with fork-style JAWS which do not clamp the conductors or the busbars.

NOTE Examples of protective measures are shrouds, PROTECTIVE BARRIERS, covers, or distances on the opposite sides of the JAW ENDS.

For the purposes of this document, it is assumed that a single JAW END is not able to short-circuit two separated conductors in an electric installation. The maximum voltage between two UNINSULATED CONDUCTORS which could be short-circuited during clamping is considered to be ~~the~~ equal to or lower than the line-to-line voltage of the distribution system for which the current sensor is RATED.

Conformity is checked by inspection and, if applicable, by the a.c. test of 6.8.3.1 with a duration of at least 1 min or, for d.c. ~~conductors~~ current sensors, the 1 min d.c. test of 6.8.3.2 using the test voltages from Table 105 applied between the test lead wires for each voltage of Table 105 up to and including the highest RATED voltage of the JAWS, while each specified test probe of Figure 106 and of Table 105 for the considered voltage is inserted into the JAW opening as shown in Figure 107.

EXAMPLE If the RATED voltage of the JAWS is 450 V, then the tests ~~will be~~ are performed with a 6 mm probe, a 10 mm probe, and a 15 mm probe.



Key

1 Non-conductive base material
2 Conductive surface material
3 Test lead wires
D Diameter of conductive surface material
X Overall thickness of test probe

Figure 106 – Test probe to check protection against short-circuits

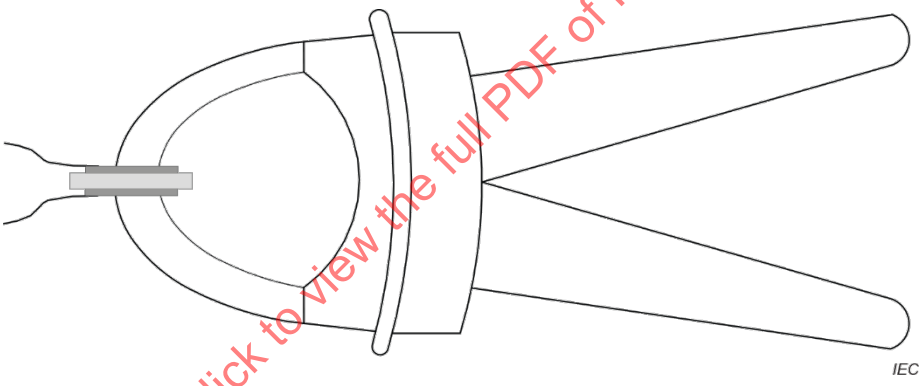


Figure 107 – Use of the test probe of Figure 106

Table 105 – Thickness of the test probe of Figure 106 and test voltages

RATED a.c. r.m.s. or d.c voltage of the JAWS V	Thickness *X* of the test probe [a] mm	Test voltage [b]	
		1 min a.c. test V r.m.s.	1 min d.c. test V d.c.
≤ 150	6	350	~~450~~ 500
> 150 ≤ 300	10	650	~~900~~ 920
> 300 ≤ 600	15	1 300	1 850
> 600 ≤ 1 000	25	2 200	3 100
> 1 000 ≤ 1 500	25	3 000	4 250
> 1 500 ≤ 2 000	25	3 750	5 300
> 2 000 ≤ 3 000	25	5 250	7 400

[a] If the JAWS do not open to the appropriate dimension, the probe thickness will equal the maximum JAW opening.

[b] The values for the test voltage apply to tests performed at 2 000 m. For other test site altitudes, the corrections of Table 10 are applied.

102.3 Protection against short-circuits in closed position

In closed position, JAWS of Type A, Type B, and Type C current sensors shall have BASIC INSULATION between the outer surface of the ENCLOSURE of the JAWS and all conductive parts including small metal parts such as screws or rivets, except the JAW ENDS. This requirement is also applicable to Type A current sensors with fork-style JAWS, by assimilating the rigid ENCLOSURE of the JAWS without the JAW ENDS being in a closed position.

Conductive parts of the JAW ENDS shall not be ACCESSIBLE in closed position.

Conformity is checked by inspection, by the tests of K.101.4 for solid insulation and by the determination of whether the JAW ENDS are ACCESSIBLE in closed position in accordance with 6.2. For the voltage tests, insulated outer surfaces of the ENCLOSURE of the JAWS are covered with metal foil everywhere except around the JAW ENDS. The distance from the foil to the JAW ENDS is the applicable CLEARANCE.

Annexes

All annexes of Part 1 are applicable except as follows.

Annex D
(normative)

Parts between which insulation requirements are specified (see 6.4 and 6.5.3)

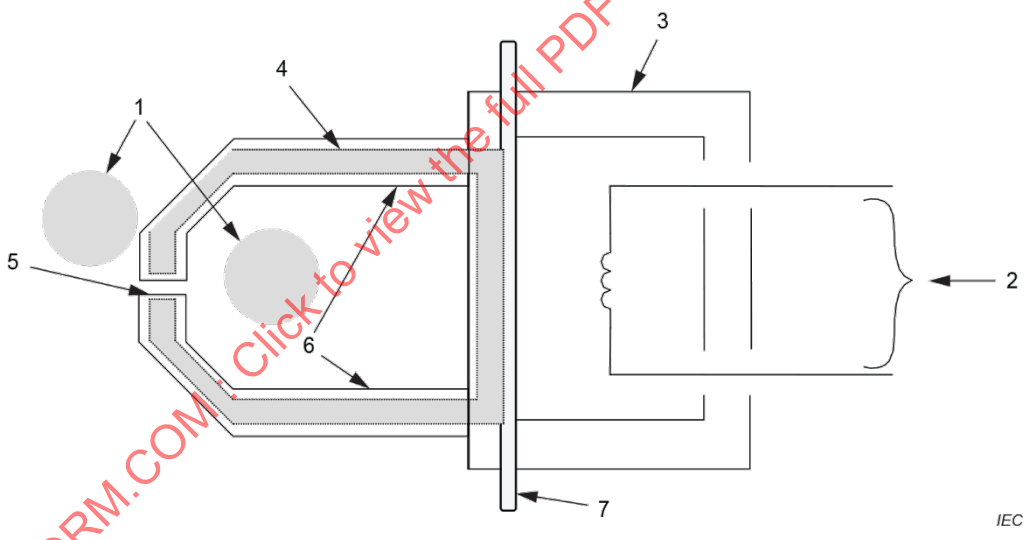
Replace the title of Annex D with the following title:

Annex D
(normative)

Parts between which insulation requirements are specified (see 6.4, 6.5.3, 6.9.101 and ~~6.9.103~~ 6.101)

Add the following new paragraph, figure and table at the end of Annex D.

Figure D.101 and Table D.101 show parts of current sensors between which insulation is required as specified.



Key

1	HAZARDOUS LIVE UNINSULATED CONDUCTOR within the JAWS or near the JAWS		
2	Input/output circuit	3	HAND-HELD or hand-manipulated parts
4	Magnetic circuit	5	JAW END
6	JAW ENCLOSURE	7	PROTECTIVE BARRIER

Figure D.101 – Parts of current sensors (see also Table D.101)

Table D.101 – Insulation requirements ~~between circuits and ACCESSIBLE parts of~~ for current sensors

Current sensor	Insulation between parts							
	1 and 2	1 and 3	1 and 4 [a]	2 and 3 [b]	2 and 5	2 and 6 [b]	3 and 5	4 and 6
Type A	D	D	B	D	D	D	D	B
Type B	D	-	B	D	D	D	-	B
Type C	D	-	B	D	-	D	-	B
Type D	NA	NA	NA	D	B	D	-	-

Numbers in the second row refer to those of Figure D.101 parts.

The following symbols are used to indicate:

- \- no requirement
- B BASIC INSULATION is required
- D DOUBLE INSULATION or REINFORCED INSULATION is required
- NA not applicable

[a] Only in closed position.

[b] Parts 3 and 6 are parts of the current sensor ENCLOSURE (see also Figures D.2 c) and D.2 d)).

Annex F
(normative)

Routine tests

F.1 General

Replace the first sentence with the following text:

The manufacturer shall perform the tests of Clauses F.2 to F.4 and Clause F.101 on 100 % of ~~equipment~~ the current sensors produced that ~~has~~ have both HAZARDOUS LIVE parts and ACCESSIBLE conductive parts.

Add the following new clause:

F.101 JAWS of current sensors

For Type A, Type B, and Type C current sensors, a test voltage for BASIC INSULATION is applied between:

a) exposed conductive parts of the JAWS or JAW ENDS, and

b) ACCESSIBLE conductive parts within the HAND-HELD or hand-manipulated area and input and output circuits connected together.

Type D current sensors and other current sensors whose JAWS and JAW ENDS do not have ACCESSIBLE conductive parts do not need to be subjected to this test.

The test voltage may be a.c. using the applicable test voltage of Table K.102, d.c. or impulse~~, and is selected from Table F.101~~ using the applicable test voltage of Table K.103, for the appropriate MEASUREMENT CATEGORY. The d.c. test voltage value is equal to 1,414 the a.c. test voltage value. For the a.c. and d.c. tests, the test voltage is raised to its specified value within 5 s, and maintained for at least 2 s. Impulse tests are the 1,2/50 μs test specified in IEC 61180 conducted for a minimum of three pulses of each polarity at 1 s minimum intervals. For current sensors ~~with no~~ not RATED for MEASUREMENT CATEGORY, the value of the test voltage is 1,5 times the RATED voltage to earth of the JAWS but not less than 350 V a.c. r.m.s. or 500 V d.c.

No flashover of CLEARANCES or breakdown of solid insulation shall occur during the test.

~~**Table F.101 – Test voltages for ROUTINE TESTS of JAWS of current sensors**~~

~~RATED a.c. r.m.s. or d.c. voltage to earth of the JAWS~~	~~MEASUREMENT CATEGORY II~~			~~MEASUREMENT CATEGORY III~~			~~MEASUREMENT CATEGORY IV~~		
	~~2 s a.c. test~~	~~2 s d.c. test~~	~~1,2/50 µs impulse~~	~~2 s a.c. test~~	~~2 s d.c. test~~	~~1,2/50 µs impulse~~	~~2 s a.c. test~~	~~2 s d.c. test~~	~~1,2/50 µs impulse~~
~~V~~	~~V r.m.s.~~	~~V d.c~~	~~V peak~~	~~V r.m.s~~	~~V d.c~~	~~V peak~~	~~V r.m.s~~	~~V d.c~~	~~V peak~~
~~≤ 150~~	~~840~~	~~1 200~~	~~1 200~~	~~1 400~~	~~2 000~~	~~2 000~~	~~2 200~~	~~3 100~~	~~3 100~~
~~> 150 ≤ 300~~	~~1 400~~	~~2 000~~	~~2 000~~	~~2 200~~	~~3 100~~	~~3 100~~	~~3 300~~	~~4 700~~	~~4 700~~
~~> 300 ≤ 600~~	~~2 200~~	~~3 100~~	~~3 100~~	~~3 300~~	~~4 700~~	~~4 700~~	~~4 300~~	~~6 000~~	~~6 000~~
~~> 600 ≤ 1 000~~	~~3 300~~	~~4 700~~	~~4 700~~	~~4 300~~	~~6 000~~	~~6 000~~	~~5 300~~	~~7 500~~	~~7 500~~

Annex K
(normative)

Insulation requirements not covered by 6.7

K.3 Insulation in circuits not addressed in 6.7, Clause K.1 or Clause K.2

Replace the existing title of Clause K.3 with the following:

K.3 Insulation for circuits not addressed in 6.7, Clauses K.1, K.2 or K.101 and for measuring circuits where MEASUREMENT CATEGORIES do not apply

K.3.1 General

~~*Addition:*~~

~~*Add the following new item aa) to the list*~~

~~aa) the circuit is a measuring circuit where MEASUREMENT CATEGORIES do not apply.~~

~~*Replacement:*~~

~~*Replace the second paragraph with the following:*~~

~~In cases a) to c) and aa), CLEARANCES for BASIC INSULATION and SUPPLEMENTARY INSULATION are determined according to K.3.2.~~

~~*Deletion:*~~

~~*Delete the note.*~~

~~*Addition:*~~

Replace the text with the following:

These circuits have one or more of the following characteristics:

a) the maximum possible TRANSIENT OVERVOLTAGE is limited by the supply source or within the current sensor (see Clause K.4.) to a known level below the level assumed for the MAINS CIRCUIT;

b) the maximum possible TRANSIENT OVERVOLTAGE is above the level assumed for the MAINS CIRCUIT;

c) the WORKING VOLTAGE is the sum of voltages from more than one circuit, or is a mixed voltage;

d) the WORKING VOLTAGE includes a recurring peak voltage that may include a periodic non-sinusoidal waveform or a non-periodic waveform that occurs with some regularity;

e) the WORKING VOLTAGE has a frequency above 30 kHz;

f) the circuit is a measuring circuit where MEASUREMENT CATEGORIES do not apply.

In cases a) to c) and f), CLEARANCES for BASIC INSULATION and SUPPLEMENTARY INSULATION are determined according to K.3.2.

In cases d) and e) CLEARANCES are determined according to K.3.3.

In all cases, K.3.4 addresses CREEPAGE DISTANCE and K.3.5 solid insulation.

NOTE These requirements are illustrated in the flowchart of Annex DD, Figure DD.1.

Add the following new clause and tables:

K.101 Insulation requirements for measuring circuits ~~of~~ RATED for MEASUREMENT categories ~~II, III and IV~~

K.101.1 General

Measuring circuits are subjected to WORKING VOLTAGES and transient stresses from the circuits to which they are connected during measurement or test. When the measuring circuit is used to measure MAINS, the transient stresses can be estimated by the location within the installation at which the measurement is performed. When the measuring circuit is used to measure any other electrical signal, the transient stresses ~~must~~ shall be considered by the OPERATOR to ensure that they do not exceed the capabilities of the measuring ~~equipment~~ current sensor.

When the measuring circuit is used to connect to MAINS, there is a RISK of arc ~~flash explosion~~ blast. MEASUREMENT CATEGORIES define the amount of energy available, which may contribute to arc flash. In conditions where arc flash may occur, additional precautions identified by the manufacturer to reduce the HAZARD related to shock and burn from arc flash should be described in the user documentation (see also Annexes AA and BB).

K.101.2 CLEARANCES

For ~~equipment~~ a current sensor intended to be powered from the circuit being measured, CLEARANCES for the MAINS CIRCUIT shall be designed according to the requirements of the RATED MEASUREMENT CATEGORY. Additional marking requirements are specified in 5.1.5.2, 5.1.5.101 and 5.1.5.102.

CLEARANCES ~~for~~ of measuring circuits ~~of~~ RATED for MEASUREMENT CATEGORIES ~~II, III and IV~~ are specified in Table K.101.

NOTE 1 See Annex I for nominal voltages of MAINS supplies.

If the ~~equipment~~ current sensor is RATED to operate at an altitude greater than 2 000 m, the values for CLEARANCES shall be multiplied by the applicable factor of Table K.1.

Minimum CLEARANCE for BASIC INSULATION, SUPPLEMENTARY INSULATION and REINFORCED INSULATION is 0,2 mm for POLLUTION DEGREE 2 and 0,8 mm for POLLUTION DEGREE 3.

NOTE 2 CLEARANCES for other measuring circuits are calculated according to Clause K.3.

Table K.101 – CLEARANCES ~~for~~ **of measuring circuits** ~~of~~
RATED for MEASUREMENT CATEGORIES ~~II, III and IV~~

~~Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured~~ V	~~CLEARANCE~~ ~~mm~~					
	~~BASIC INSULATION and SUPPLEMENTARY INSULATION~~			~~REINFORCED INSULATION~~		
	~~MEASUREMENT CATEGORY II~~	~~MEASUREMENT CATEGORY III~~	~~MEASUREMENT CATEGORY IV~~	~~MEASUREMENT CATEGORY II~~	~~MEASUREMENT CATEGORY III~~	~~MEASUREMENT CATEGORY IV~~
~~≤ 50~~	~~0,04~~	~~0,1~~	~~0,5~~	~~0,1~~	~~0,3~~	~~1,5~~
~~> 50 ≤ 100~~	~~0,1~~	~~0,5~~	~~1,5~~	~~0,3~~	~~1,5~~	~~3,0~~
~~> 100 ≤ 150~~	~~0,5~~	~~1,5~~	~~3,0~~	~~1,5~~	~~3,0~~	~~6,0~~
~~> 150 ≤ 300~~	~~1,5~~	~~3,0~~	~~5,5~~	~~3,0~~	~~5,9~~	~~10,5~~
~~> 300 ≤ 600~~	~~3,0~~	~~5,5~~	~~8~~	~~5,9~~	~~10,5~~	~~14,3~~
~~> 600 ≤ 1 000~~	~~5,5~~	~~8~~	~~14~~	~~10,5~~	~~14,3~~	~~24,3~~

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	CLEARANCE mm					
	BASIC INSULATION and SUPPLEMENTARY INSULATION			REINFORCED INSULATION		
	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV
≤ 50	0,04	0,1	0,5	0,1	0,32	1,4
> 50 ≤ 100	0,1	0,5	1,5	0,32	1,4	3,0
> 100 ≤ 150	0,5	1,5	3,0	1,4	3,0	6,0
> 150 ≤ 300	1,5	3,0	5,5	3,0	6	10,4
> 300 ≤ 600	3,0	5,5	8	6	10,4	15
> 600 ≤ 1 000	5,5	8	14	10,4	15	23,9
> 1 000 ≤ 1 500	8	11	18	16	22	36
> 1 500 ≤ 2 000	14	18	22	28	36	44
> 2 000 ≤ 3 000	18	22	25	36	44	50

Conformity is checked by inspection and measurement or by the a.c. voltage test of 6.8.3.1 with a duration of at least 5 s, or the impulse voltage test of 6.8.3.3, or, for measuring circuits stressed only by d.c., the d.c. voltage test of 6.8.3.2 with a duration of at least 5 s, using the applicable test voltage of Table K.16 for the required CLEARANCE. The value of the d.c. test voltage is √2 times the a.c. r.m.s. test voltage.

K.101.3 CREEPAGE DISTANCES

The requirements of K.2.3 apply.

Conformity is checked as specified in K.2.3.

K.101.4 Solid insulation

K.101.4.1 General

K.101.4.1.1 Solid insulation shall withstand the electrical and mechanical stresses that may occur in NORMAL USE, in all RATED environmental conditions (see 1.4), during the intended life of the ~~equipment~~ current sensor.

The manufacturer should take the expected life of the ~~equipment~~ current sensor into account when selecting insulating materials.

Conformity is checked by both of the following tests:

a) the a.c. voltage test of 6.8.3.1 with a duration of at least 5 s using the applicable test voltage of Table K.102 or the impulse voltage test of 6.8.3.3 using the applicable test voltage of ~~Table K.102,~~ Table K.103 ~~or Table K.104~~, including for measuring circuits stressed only by d.c.;

b) the a.c. voltage test of 6.8.3.1 with a duration of at least 1 min or, for ~~MAINS~~ measuring circuits stressed only by d.c., the ~~1 min~~ d.c. voltage test of 6.8.3.2 with a duration of at least 1 min using the ~~applicable~~ test voltage ~~of Table K.105~~ determined by K.101.4.1.2.

NOTE Test a) checks the effects of TRANSIENT OVERVOLTAGES, while test b) checks the effects of long-term stress of solid insulation.

Table K.102 – a.c. test voltages for testing electric strength of solid insulation in measuring circuits ~~of~~ RATED for MEASUREMENT ~~CATEGORY II~~ CATEGORIES

~~Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured~~ V	~~Test voltage~~			
	~~5 seconds a.c. test~~ V r.m.s.		~~Impulse test~~ V peak	
	~~BASIC INSULATION and SUPPLEMENTARY INSULATION~~	~~REINFORCED INSULATION~~	~~BASIC INSULATION and SUPPLEMENTARY INSULATION~~	~~REINFORCED INSULATION~~
~~≤ 150~~	~~840~~	~~1 390~~	~~1 550~~	~~2 500~~
~~> 150 ≤ 300~~	~~1 390~~	~~2 210~~	~~2 500~~	~~4 000~~
~~> 300 ≤ 600~~	~~2 210~~	~~3 510~~	~~4 000~~	~~6 400~~
~~> 600 ≤ 1 000~~	~~3 310~~	~~5 400~~	~~6 000~~	~~9 600~~

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	a.c. test voltage V r.m.s.					
	BASIC INSULATION and SUPPLEMENTARY INSULATION			REINFORCED INSULATION		
	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV
≤ 50	370	500	840	500	720	1 300
> 50 ≤ 100	500	840	1 400	720	1 300	2 200
> 100 ≤ 150	840	1 400	2 200	1 300	2 200	3 500
> 150 ≤ 300	1 400	2 200	3 300	2 200	3 500	5 100
> 300 ≤ 600	2 200	3 300	4 300	3 500	5 100	7 000
> 600 ≤ 1 000	3 300	4 300	6 600	5 100	7 000	10 000
> 1 000 ≤ 1 500	4 300	5 400	8 200	7 400	9 700	15 000
> 1 500 ≤ 2 000	6 600	8 200	9 700	12 000	15 000	18 000
> 2 000 ≤ 3 000	8 200	9 700	11 000	15 000	18 000	20 000

Table K.103 – Impulse test voltages for testing electric strength of solid insulation in measuring circuits of RATED for MEASUREMENT CATEGORY III CATEGORIES

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	Test voltage			
	5 seconds a.c. test V r.m.s.		Impulse test V peak	
	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION
≤ 150	1 390	2 210	2 500	4 000
> 150 ≤ 300	2 210	3 510	4 000	6 400
> 300 ≤ 600	3 310	5 400	6 000	9 600
> 600 ≤ 1 000	4 260	7 400	8 000	12 800

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	Impulse test voltage V peak					
	BASIC INSULATION and SUPPLEMENTARY INSULATION			REINFORCED INSULATION		
	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV
≤ 50	500	800	1 500	800	1 280	2 400
> 50 ≤ 100	800	1 500	2 500	1 280	2 400	4 000
> 100 ≤ 150	1 500	2 500	4 000	2 400	4 000	6 400
> 150 ≤ 300	2 500	4 000	6 000	4 000	6 400	9 600
> 300 ≤ 600	4 000	6 000	8 000	6 400	9 600	12 800
> 600 ≤ 1 000	6 000	8 000	12 000	9 600	12 800	19 200
> 1 000 ≤ 1 500	8 000	10 000	15 000	13 500	17 900	27 100
> 1 500 ≤ 2 000	12 000	15 000	18 000	21 400	27 100	32 000
> 2 000 ≤ 3 000	15 000	18 000	20 000	27 100	32 000	36 000

K.101.4.1.2 Test voltage values for testing the long-term stress of solid insulation are determined as follows:

The test voltage for BASIC INSULATION and SUPPLEMENTARY INSULATION is calculated with the following formula:

$$U_T = A \times U_N + B$$

where U_T is the test voltage, U_N is the nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured and A and B are parameters determined as follows:

when $U_N \leq 1\,000$ V, $A = 1$ and $B = 1\,200$ V

when $U_N > 1\,000$ V, $A = 1{,}5$ and $B = 750$ V

The a.c. test voltage is equal to U_T and the d.c. test voltage is equal to $1{,}414 \times U_T$.

For REINFORCED INSULATION, the test voltage value is twice the value for BASIC INSULATION.

The rounded values of Table K.104 can also be used:

Table K.104 –Test voltages for testing ~~electric strength~~ long-term stress of solid insulation in measuring circuits ~~of~~ RATED for MEASUREMENT ~~CATEGORY IV~~ CATEGORIES

~~Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured~~ ~~V~~	~~Test voltage~~			
	~~5 seconds a.c. test~~ ~~V r.m.s.~~		~~Impulse test~~ ~~V peak~~	
	~~BASIC INSULATION and SUPPLEMENTARY INSULATION~~	~~REINFORCED INSULATION~~	~~BASIC INSULATION and SUPPLEMENTARY INSULATION~~	~~REINFORCED INSULATION~~
~~≤ 150~~	~~2 210~~	~~3 510~~	~~4 000~~	~~6 400~~
~~> 150 ≤ 300~~	~~3 310~~	~~5 400~~	~~6 000~~	~~9 600~~
~~> 300 ≤ 600~~	~~4 260~~	~~7 400~~	~~8 000~~	~~12 800~~
~~> 600 ≤ 1 000~~	~~6 600~~	~~11 940~~	~~12 000~~	~~19 200~~

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	Test voltage			
	1-min a.c. test V r.m.s.		1-min d.c. test V d.c.	
	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION
≤ 50	1 250	2 500	1 750	3 500
> 50 ≤ 100	1 300	2 600	1 850	3 700
> 100 ≤ 150	1 350	2 700	1 900	3 800
> 150 ≤ 300	1 500	3 000	2 100	4 200
> 300 ≤ 600	1 800	3 600	2 550	5 100
> 600 ≤ 1 000	2 200	4 400	3 100	6 200
> 1 000 ≤ 1 500	3 000	6 000	4 250	8 500
> 1 500 ≤ 2 000	3 750	7 500	5 300	10 600
> 2 000 ≤ 3 000	5 250	10 500	7 400	14 800

~~Table K.105 – Test voltages for testing long term stress of solid insulation in measuring circuits~~

~~Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured~~ ~~V~~	~~Test voltage~~			
	~~1 min a.c. test~~ ~~V r.m.s.~~		~~1 min d.c. test~~ ~~V d.c.~~	
	~~BASIC INSULATION and SUPPLEMENTARY INSULATION~~	~~REINFORCED INSULATION~~	~~BASIC INSULATION and SUPPLEMENTARY INSULATION~~	~~REINFORCED INSULATION~~
~~≤ 150~~	~~1 350~~	~~2 700~~	~~1 900~~	~~3 800~~
~~> 150 ≤ 300~~	~~1 500~~	~~3 000~~	~~2 100~~	~~4 200~~
~~> 300 ≤ 600~~	~~1 800~~	~~3 600~~	~~2 550~~	~~5 100~~
~~> 600 ≤ 1 000~~	~~2 200~~	~~4 400~~	~~3 100~~	~~6 200~~

K.101.4.1.3 Solid insulation shall also meet the following requirements, as applicable:

1) for solid insulation used as an ENCLOSURE or PROTECTIVE BARRIER, the requirements of Clause 8;
2) for moulded and potted parts, the requirements of K.101.4.2;
3) for ~~inner~~ insulating layers of printed wiring boards, the requirements of K.101.4.3;
4) for thin-film insulation, the requirements of K.101.4.4.

Conformity is checked as specified in K.101.4.2 to K.101.4.4, and Clause 8, as applicable.

K.101.4.2 Moulded and potted parts

For BASIC INSULATION, SUPPLEMENTARY INSULATION, and REINFORCED INSULATION, conductors located between the same two layers moulded together (see Figure K.1, item L) shall be separated by at least the applicable minimum distance of Table K.~~9~~105 after the moulding is completed.

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

K.101.4.3 ~~Inner~~ Insulating layers of printed wiring boards

For BASIC INSULATION, SUPPLEMENTARY INSULATION and REINFORCED INSULATION, conductors located between the same two layers (see Figure K.2, item L) shall be separated by at least the applicable minimum distance of Table K.~~9~~105.

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

Table K.105 – Minimum values for distance or thickness of solid insulation in measuring circuits RATED FOR MEASUREMENT CATEGORIES

Line-to-neutral voltage V r.m.s. or d.c.	Minimum thickness [a] mm	Minimum distance L (see Figure K.2) [a, b] mm
≤ 300	0,4	0,4
> 300 ≤ 600	0,6	0,6
> 600	1,0	1,0

[a] These values are independent of the MEASUREMENT CATEGORY.

[b] These values apply for BASIC INSULATION, SUPPLEMENTARY INSULATION and REINFORCED INSULATION.

REINFORCED INSULATION of inner insulating layers of printed wiring boards shall also have adequate electric strength through the respective layers. One of the following methods shall be used.

a) The thickness through the insulation is at least the applicable value of Table K.~~9~~105.

   Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

b) The insulation is assembled from at least two separate layers of printed wiring board materials, each of which is RATED by the manufacturer of the material for an electric strength of at least the value of the applicable test voltage of Table K.102 or Table K.103 ~~or Table K.104~~ for BASIC INSULATION.

   Conformity is checked by inspection of the manufacturer's specifications.

c) The insulation is assembled from at least two separate layers of printed wiring board materials, and the combination of layers is RATED by the manufacturer of the material for an electric strength of at least the value of the applicable test voltage of Table K.102 or of Table K.103 ~~or Table K.104~~ for REINFORCED INSULATION.

Conformity is checked by inspection of the manufacturer's specifications.

K.101.4.4 Thin-film insulation

For BASIC INSULATION, SUPPLEMENTARY INSULATION and REINFORCED INSULATION, conductors located between the same two layers (see Figure K.3, item L) shall be separated by at least the applicable CLEARANCE and CREEPAGE DISTANCE of K.101.2 and K.101.3.

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

REINFORCED INSULATION through the layers of thin-film insulation shall also have adequate electric strength. One of the following methods shall be used.

a) The thickness through the insulation is at least the applicable value of Table K.~~9~~105.

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

b) The insulation consists of at least two separate layers of thin-film materials, each of which is RATED by the manufacturer of the material for an electric strength of at least the value of the applicable test voltage of Table K.102 or Table K.103 ~~or Table K.104~~ for BASIC INSULATION.

Conformity is checked by inspection of the manufacturer's specifications.

c) The insulation consists of at least three separate layers of thin-film materials, any two of which have been tested to exhibit adequate electric strength.

~~*Conformity is checked by the a.c. voltage test of 6.8.3.1 with a duration of at least 1 min applied to two of the three layers using the applicable test voltage of Table K.102, Table K.103 or Table K.104 for REINFORCED INSULATION.*~~

Conformity is checked by the voltage tests of K.101.4.1.1 applied to two of the three layers for REINFORCED INSULATION.

For the purposes of these tests, a special sample may be assembled with only two layers of the material.

Annex L
(informative)

Index of defined terms

Add the following defined terms:

Add the following new annexes ~~AA and BB~~:

Annex AA
(normative)

MEASUREMENT CATEGORIES

AA.1 General

For the purposes of this document, the following MEASUREMENT CATEGORIES are used. These MEASUREMENT CATEGORIES are not the same as the OVERVOLTAGE CATEGORIES in accordance with Annex K of Part 1 and with IEC 60664-1, or the classification of rated impulse ~~withstand categories~~ voltages (overvoltage categories) in accordance with IEC 60364-4-44.

MEASUREMENT CATEGORIES are based on locations on the MAINS ~~supply system~~ where measurements may be made.

NOTE IEC 60664-1 and IEC 60364-4-44 categories are created to achieve an insulation coordination of the components and equipment used within ~~the low-voltage MAINS supply system~~ MAINS.

AA.2 MEASUREMENT CATEGORIES

AA.2.1 MEASUREMENT CATEGORY II

MEASUREMENT CATEGORY II is applicable to test and measuring circuits connected directly to utilization points (socket outlets and similar points) of the low-voltage MAINS installation (see Table AA.1 and Figure AA.1).

EXAMPLE Measurements on MAINS CIRCUITS of household appliances, portable TOOLS and similar equipment, and on the consumer side only of socket-outlets in the fixed installation.

AA.2.2 MEASUREMENT CATEGORY III

MEASUREMENT CATEGORY III is applicable to test and measuring circuits connected to the distribution part of the building's low-voltage MAINS installation (see Table AA.1 and Figure AA.1).

To avoid RISKS caused by the HAZARDS arising from these higher short-circuit currents, additional insulation and other provisions are required.

For equipment that is part of a fixed installation, the fuse or circuit breaker of the installation is considered to provide adequate protection against short-circuit currents.

EXAMPLE Measurements on distribution boards (including secondary meters), photovoltaic panels, circuit-breakers, wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and equipment for industrial use and some other equipment such as stationary motors with permanent connection to the fixed installation.

AA.2.3 MEASUREMENT CATEGORY IV

MEASUREMENT CATEGORY IV is applicable to test and measuring circuits connected at the source of the building's low-voltage MAINS installation (see Table AA.1 and Figure AA.1).

~~Due to these high short-circuit currents which can be followed by a highenergy level, measurements made within these locations are extremely dangerous. Great precautions shall be made to avoid any chance of a shortcircuit.~~

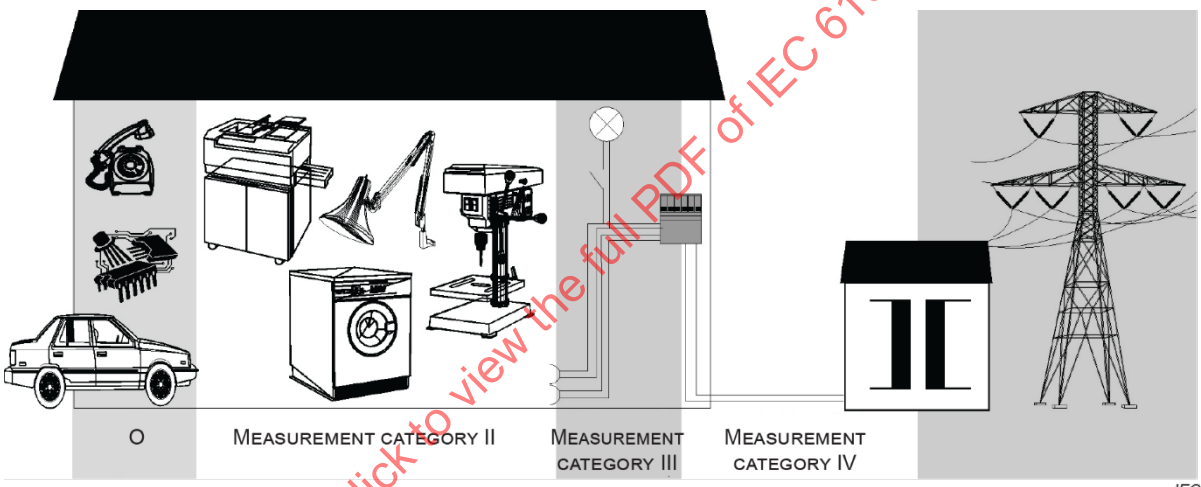
Owing to the high potential short-circuit currents existing in these circuits, any accidental short-circuit caused whilst making measurements can create a high-energy-level arc flash which is extremely dangerous to bystanders in the immediate vicinity. Great precautions shall be taken to avoid any chance of a short-circuit.

EXAMPLE Measurements on devices installed before the main fuse or circuit breaker in the building installation.

AA.2.4 Measuring circuits without a MEASUREMENT CATEGORY RATING

Many types of test and measuring circuits are not intended to be directly connected to the MAINS supply. Some of these measuring circuits are intended for very low energy applications, but others of these measuring circuits may experience very high amounts of available energy because of high short-circuit currents or high open-circuit voltages. There are no standard transient levels defined for these circuits. An analysis of the WORKING VOLTAGES, loop impedances, TEMPORARY OVERVOLTAGES, and TRANSIENT OVERVOLTAGES in these circuits is necessary to determine the insulation requirements and short-circuit current requirements.

EXAMPLE Thermocouple measuring circuits, high-frequency measuring circuits, automotive testers, and testers used to characterize the MAINS installation before the installation is connected to the MAINS supply.



Key

O ~~Other circuits that are not directly connected to MAINS~~ Measuring circuits without a MEASUREMENT CATEGORY

CAT II MEASUREMENT CATEGORY II

CAT III MEASUREMENT CATEGORY III

CAT IV MEASUREMENT CATEGORY IV

Figure AA.1 – Example to identify the locations of measuring circuits

Table AA.1 – Characteristics of MEASUREMENT CATEGORIES

MEASUREMENT CATEGORY	Short-circuit current[a] (typical) kA	Location in the building installation
II	< 10	Circuits connected to MAINS socket outlets and similar points in the MAINS installation
III	< 50	MAINS distribution parts of the building
IV	~~>>~~ > 50	Source of the MAINS installation in the building

a ~~The short-circuit current is calculated for a 1 000 V line-to-neutral voltage and the minimum loop impedance.~~

The values of loop impedances (installation impedances) do not take into account the resistance of the test leads and impedances internal to the measuring equipment. These short-circuit currents vary, depending on the characteristics of the installation.

Annex BB
(informative)

HAZARDS pertaining to measurements performed in certain environments

BB.1 General

Annex BB provides guidance to the equipment manufacturer on HAZARDS that should be considered for equipment intended to measure electrical quantities in certain environments. This list of HAZARDS is not to be considered comprehensive: other HAZARDS certainly exist in these and other environments.

BB.2 ~~MAINS CIRCUITS~~ HAZARDS

BB.2.1 General

Testing and measuring circuits are subjected to WORKING VOLTAGES and transient stresses from the circuit to which they are connected during measurement or test. When the measuring circuit is used to measure MAINS, the transient stresses can be estimated by the location within the installation at which the measurement is performed.

BB.2.2 Electric shock

MAINS circuits present a HAZARD of electric shock. The voltages and currents are above the permissible levels (see 6.3), and access to the circuit is usually required to perform the measurement. The manufacturer should provide adequate information to permit the OPERATOR to be aware of the HAZARD of electric shock, and should ensure that the design requirements of this document and those of other related documents (for example, IEC 61010-031 for voltage probe assemblies) are met.

BB.2.3 Arc ~~flash~~ blast

Arc flash occurs when a conductor (such as a probe tip or a low-impedance measuring circuit) temporarily bridges two high-energy conductors and then opens or is withdrawn. This can result in arcing, which ionizes the air. Ionized air is conductive and can result in continued current flow in the vicinity of the conductors.

The arc flash will release significant amounts of very hot air and molten or vaporised metal particles (from the active conductors) which are the primary RISK to the OPERATOR and other persons in the immediate vicinity.

If there is sufficient available energy, then the ionization of the air will continue to spread and the flow of current through the air continues to increase. The result is similar to an explosion, and can cause significant injury or death to an OPERATOR or a bystander. See the descriptions of the MEASUREMENT CATEGORIES in Annex AA for the voltage and energy levels likely to cause arc flash.

BB.~~3~~2.4 Thermal burns

Any conductor (such as jewellery) that connects two high-energy conductors may become hot from current flow through the item. This can cause burns to the skin adjacent to the item.

BB.3 MAINS

When the measuring circuit is used to measure live MAINS, there is a RISK of arc ~~flash explosion~~ blast. MEASUREMENT CATEGORIES (see Annex AA) define the amount of energy available, which may contribute to arc flash. In conditions where arc flash can exist, the instructions for use need to specify additional precautions to reduce the HAZARD related to shock and burn from arc flash.

BB.4 Telecommunications networks

The voltages and currents continually present in telecommunications networks are below the levels that could be considered HAZARDOUS LIVE. However, the "ring" voltages (the voltage imposed on the telecommunications line to indicate that the telephone receiver should signal an incoming call) are typically around 90 V a.c., which is considered HAZARDOUS LIVE. If a technician were to come into contact with the ~~proper~~ hazardous conductor while the ring event occurred, then the technician could suffer an electric shock.

EN 41003~~:1999~~ addresses safety requirements for equipment to be connected to telecommunications networks. It addresses the possibility of electric shock from contact with telecommunications conductors, and concludes that, with the access limitations imposed by the connectors, the RISK is reduced to a negligible level. However, if in the process of test or measurement, the conductor is made fully ACCESSIBLE, then there is a possibility of electric shock.

The manufacturer of equipment that may be used for testing and ~~measurement~~ measuring of telecommunications networks should be aware of the HAZARD from the ring voltage and should take suitable steps to reduce the HAZARD (where possible by limiting access to the conductors; in other cases, by providing adequate instructions and warnings to the OPERATOR). Also see IEC 61010-031, which specifies barriers for voltage probes that may be used on HAZARDOUS LIVE voltages.

BB.5 Current measurements in inductive circuits

When a current-measuring device is inserted in series with an inductive circuit, a HAZARD may occur if the circuit is suddenly opened (a probe falls off or a fuse opens, for example). Such sudden events can produce an inductive voltage spike across the unintentional opening of the circuit. These spikes can be many times the magnitude of the WORKING VOLTAGE of the circuit, and can cause breakdown of insulation or electric shock to an OPERATOR.

The manufacturer should provide adequate instructions to an OPERATOR to ensure that current-measuring devices are not used in series with inductive circuits, or if it is necessary to do so, then precautions are taken to mitigate the HAZARD of electric shock from the voltage spike.

BB.6 Battery-driven circuits

Batteries can present electrical, explosion and fire HAZARDS to the person conducting tests on them or their associated circuits. Examples include batteries used for stand-by sources or to operate motors.

HAZARDS may arise from electric shock, explosions from short-circuiting the TERMINALS of the battery, or explosions from arc ignition of gases evolved from the battery during charging cycles.

BB.7 Measurements at higher frequencies

Some measuring equipment depends on inductive connection to the circuit being measured. The behaviour of the measuring circuit will, in these cases, depend on the frequency of the signal being measured. If the measuring device is used to measure a frequency higher than it was designed for, then circulating currents could cause significant heating of some of the conductive parts of the measuring device.

The manufacturer should provide adequate instructions for the use of such devices.

Annex CC
(informative)

4-mm "banana" TERMINALS

CC.1 General

A HAZARD may arise from an OPERATOR's reliance on values displayed by the current sensor when connectors and TERMINALS appear to be in mated position but conductive parts are not in contact.

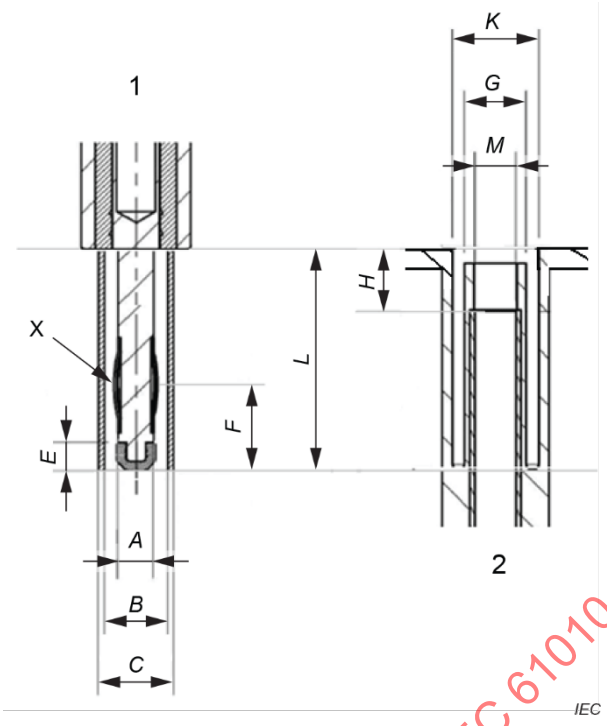
Annex CC gives the recommended dimensions for safety purposes of 4-mm TERMINALS when probe assemblies complying with IEC 61010-031:2015/AMD1:2018, Annex E, can be connected. These 4-mm TERMINALS are often called "banana connectors".

CC.2 Dimensions

The dimensions of Figure CC.1 are compatible with the requirements of TERMINALS RATED for MEASUREMENT CATEGORIES up to 1 000 V.

These dimensions ensure that the CLEARANCES of 6.6.101 are met when the connectors and TERMINALS are mated, unmated or partially mated, and that conductive parts of mated connectors and TERMINALS are in contact.

NOTE Extraction or insertion forces and contact resistance values have not been considered.



Key:

A = 3,90 mm ± 0,05 mm (compressed)	*M* = 4,00 mm + 0,05 mm
B ≥ 6,6 mm	*G* ≤ 6,4 mm
C ≤ 7,9 mm	*K* ≥ 8,1 mm
2,6 mm ≤ *E* ≤ 6 mm	4 mm ≤ *H* ≤ 6 mm
F ≤ 12 mm	*L* ≥ 20 mm

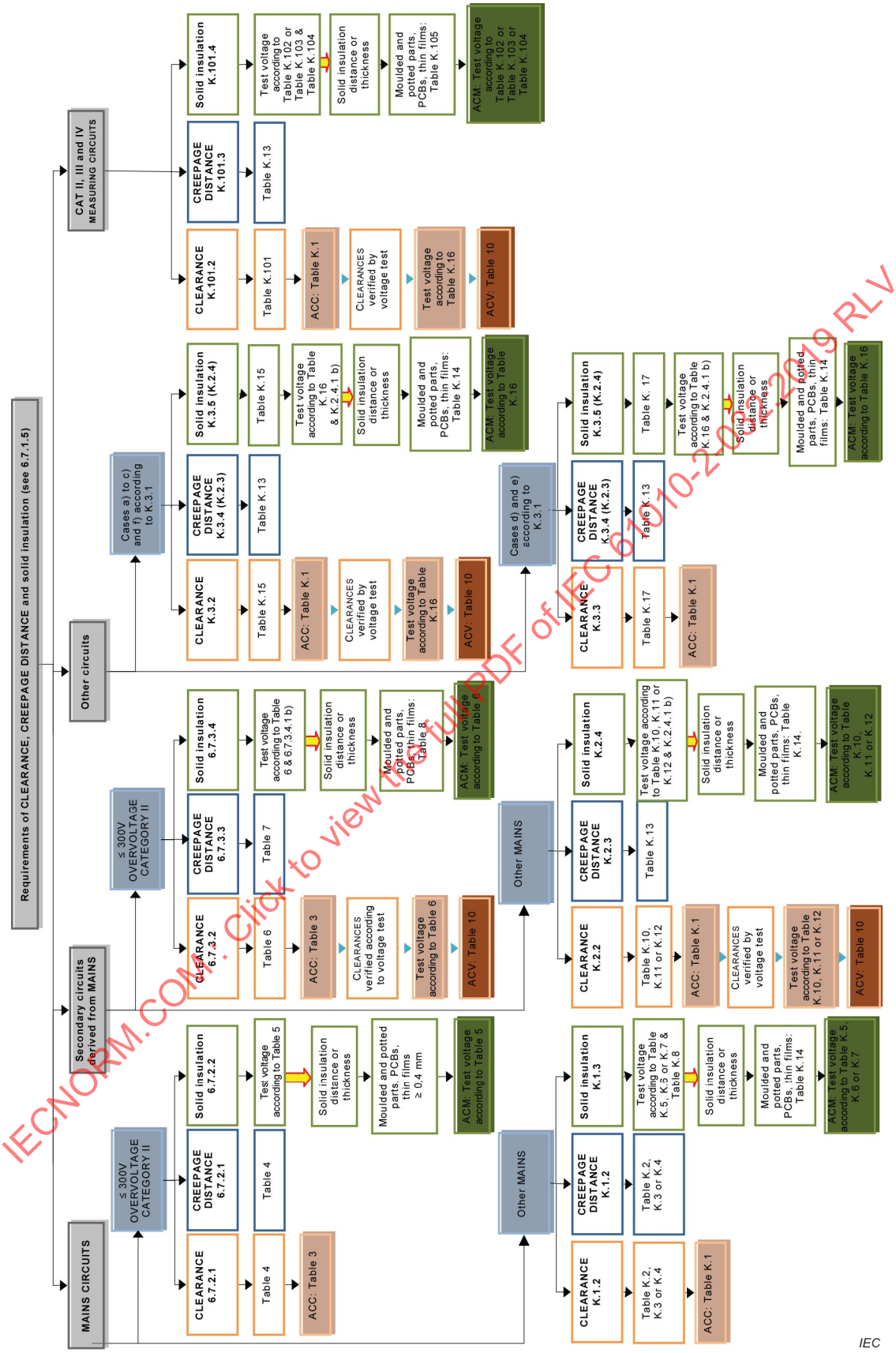
– 1 is a male TERMINAL
– 2 is a female TERMINAL
– X is the point where the best contact occurs
– The minimum value of *E* and *H* depends on whether or not plastic parts are present. CLEARANCES shall be at least 2,6 mm.

Figure CC.1 – Recommended dimensions of 4-mm TERMINALS

Annex DD
(informative)

Flowchart for insulation according to the type of circuit

A circuit can fall under more than one category. It is then necessary to follow two or more branches of the flowchart of Figure DD.1 and compare the results. For example, a measuring circuit can be RATED for MEASUREMENT CATEGORY III and can also be RATED for measuring signals at 1 MHz. This measuring circuit has to be evaluated under both K.3.3 and Clause K.101.



Key

ACC	RATED altitude correction of CLEARANCE
ACV	Site altitude correction of test voltage
&	Both required
ACM	Alternative conformity means
	As applicable
	Optional test path

Figure DD.1 – Requirements for CLEARANCE, CREEPAGE DISTANCE and solid insulation

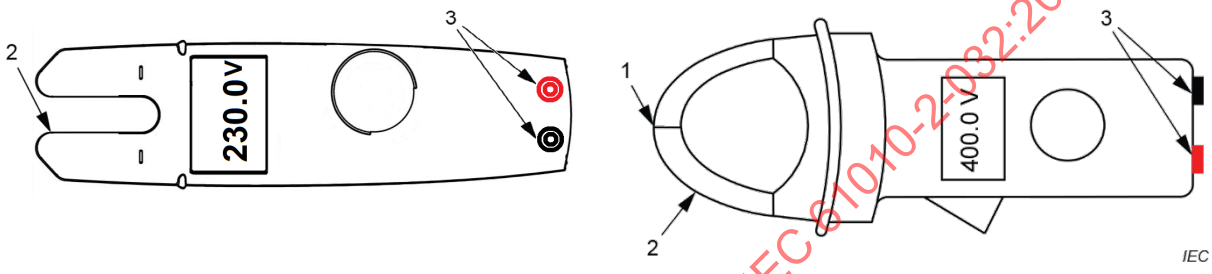
Annex EE
(normative)

CLAMP MULTIMETER

EE.1 General

The primary purpose of CLAMP MULTIMETERS is to measure current and voltage on a live MAINS. The circuit of a CLAMP MULTIMETER to measure current is a Type A or a Type B current sensor.

The following Figure EE.1 shows graphical representations of typical CLAMP MULTIMETERS for illustration purposes. CLAMP MULTIMETERS may look different depending on the design.



CLAMP MULTIMETER
with fork-style JAWS Type A current sensor

CLAMP MULTIMETER
with clamping Type A current sensor

Key

1 JAW END(S)

2 JAW

3 Input measuring circuit TERMINALS

Figure EE.1 – Examples of CLAMP MULTIMETERS

HAND-HELD clamp meters such as wattmeters, clamps for process control or clamps falling within the scope of IEC 61557-1 to IEC 61557-12 are not considered as CLAMP MULTIMETERS.

Clauses EE.2 to EE.5 give additional requirements for CLAMP MULTIMETERS.

EE.2 CLAMP MULTIMETER RATING

TERMINALS of measuring circuits intended for MAINS voltage measurements and JAWS shall be RATED for a minimum of 300 V a.c. r.m.s. to earth, and a minimum MEASUREMENT CATEGORY III.

The RATED voltage of the TERMINALS of a measuring circuit intended for MAINS voltage measurements shall be equal to or higher than their RATED voltage to earth.

NOTE These TERMINALS can also have RATINGS for other functions.

Conformity is checked by inspection.

EE.3 Marking of measuring circuit TERMINALS and JAWS

TERMINALS of measuring circuits RATED for MAINS voltage measurements and JAWS shall be marked "CAT III" and/or "CAT IV" as applicable. Only marking with both of these MEASUREMENT CATEGORIES associated with their RATED voltage to earth is permissible.

Conformity is checked by inspection.

EE.4 Probe assemblies and accessories

At minimum, one set of the test leads supplied with the CLAMP MULTIMETER shall be RATED according to IEC 61010-031 for at least the highest voltage and MEASUREMENT CATEGORY of the CLAMP MULTIMETER.

Conformity is checked by inspection.

EE.5 Indicating devices

EE.5.1 General

No HAZARD shall occur from reading a voltage value when the CLAMP MULTIMETER is operated for measuring voltages as RATED and in case of REASONABLE FORESEEABLE MISUSE.

A displayed voltage value is considered to be unambiguous when the value is less than 10 % inaccurate, or if there is an indication that the value is out of range when it should be, or if there is a clear indication that the value is not correct. A display off is also considered to be unambiguous.

The tests of EE.5.2, EE.5.3 and EE.5.4 shall be performed when relevant.

The a.c. r.m.s. voltages applied to the TERMINALS during the tests have a frequency of 50 Hz or 60 Hz. The CLAMP MULTIMETER is not required to maintain its normal accuracy during and after the tests.

EE.5.2 Battery level

A voltage value displayed by the CLAMP MULTIMETER shall not be affected by the expected variation of its battery voltage.

Conformity is checked by the following test.

For each measuring circuit TERMINALS RATED for MAINS voltage measurements, the voltage below is applied to these TERMINALS:

– *a.c. measurement TERMINALS are connected to 60 V a.c. r.m.s.*

– *d.c. measurement TERMINALS are connected to 120 V d.c.*

The supply voltage of the d.c. source connected to the battery connectors decreases by no more than 20 mV/s from the maximum battery voltage to zero. The d.c. source used for this test shall be the batteries or similar source while the impedance of the batteries and ripple free conditions are taken into account. The test terminates when the display turns off.

The displayed voltage values during the test shall be unambiguous.

NOTE See EE.5.1 for the meaning of the term "unambiguous".

EE.5.3 Over-range voltages

The CLAMP MULTIMETER shall be able to display unambiguously over-range voltage values whenever the value is above the maximum absolute value of the range to which the CLAMP MULTIMETER is set.

NOTE Examples of ambiguous indications include the following, unless there is a separate unambiguous indication of an over-range value:

a) analogue CLAMP MULTIMETER which stops at the exact ends of the range;

b) digital CLAMP MULTIMETER which shows a low value when the true value is above the range maximum (for example 1 001,5 V displayed as 001,5 V).

Conformity is checked by the following test.

An over-range voltage is applied to the measuring circuit TERMINALS RATED for MAINS voltage measurements of the CLAMP MULTIMETER set to each voltage measurement range.

The value of the over-range voltage applied to the TERMINALS is equal to 110 % of the RATED voltage measurement range. For measurement RATED for d.c., the over-range voltage is applied with positive and negative polarities.

The displayed voltage values during the test shall be unambiguous.

EE.5.4 Permanent overvoltages

The CLAMP MULTIMETER shall be able to withstand permanent overvoltages and continue to give an unambiguous indication of any HAZARDOUS LIVE voltages up to the maximum RATED voltage.

NOTE 1 Subclause 101.4 provides protection against HAZARDS from TRANSIENT OVERVOLTAGES.

Conformity is checked by the following test:

An overvoltage is applied for 5 min to the measuring circuit TERMINALS RATED for MAINS voltage measurements of the CLAMP MULTIMETER set to each voltage measurement range.

The value of the overvoltage applied to the TERMINALS is based on the TERMINALS' RATED voltage:

a) when the TERMINALS' RATED voltage value is up to 1 000 V a.c. r.m.s., the overvoltage value is the TERMINALS' RATED voltage value multiplied by 1,9 but without exceeding 1 100 V a.c. r.m.s.;

b) when the TERMINALS' RATED voltage value is above 1 000 V a.c. r.m.s. the overvoltage value is the RATED voltage value multiplied by 1,1;

c) when the TERMINALS' RATED voltage is d.c., the overvoltage value is the RATED voltage value multiplied by 1,1.

NOTE 2 The 1,9 multiplication factor is derived from phase-to-phase voltage measurements with a 10 % overvoltage condition.

After each overvoltage has been applied, each measuring circuit TERMINAL RATED for MAINS voltage measurements shall in turn:

1) measure a voltage of 60 V a.c. r.m.s. or 120 V d.c. based on the measurement TERMINAL input type;

2) measure a voltage equal to the maximum RATED voltage for the measurement TERMINAL under test.

The above test may need to be repeated at any combination of settings, TERMINALS and voltage RATING. The displayed voltage values shall be unambiguous.

Bibliography

The Bibliography of Part 1 is applicable, except as follows:

~~*Addition:*~~

Add the following references:

IEC 61010-2-033, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-033: Particular requirements for ~~HANDHELD~~ hand-held multimeters ~~and other METERS~~ for domestic and professional use capable of measuring mains voltage*

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, *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*

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 61557-3, *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 3: Loop impedance*

IEC 61557-4, *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 61557-5, *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 5: Resistance to earth*

IEC 61557-6, *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 6: Effectiveness of residual current devices (RCD) in TT, TN and IT systems*

IEC 61557-7, *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 7: Phase sequence*

IEC 61557-8, *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 8: Insulation monitoring devices for IT systems*

IEC 61557-9, *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 9: Equipment for insulation fault location in IT systems*

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 and monitoring of protective measures*

IEC 61557-11, *Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 11: Effectiveness of residual current monitors (RCMs) type A and type B in TT, TN and IT systems*

IEC 61557-12, *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 12: Power metering and monitoring devices (PMD)*

IEC TS 62993:2017, *Guidance for determination of clearances, creepage distances and requirements for solid insulation for equipment with a rated voltage above 1 000 V AC and 1 500 V DC, and up to 2 000 V AC and 3 000 V DC*

EN 41003:1999, *Particular safety requirements for equipment to be connected to telecommunications networks and/or a cable distribution system*

IEC 61010-2-032

Edition 4.0 2019-06

INTERNATIONAL STANDARD

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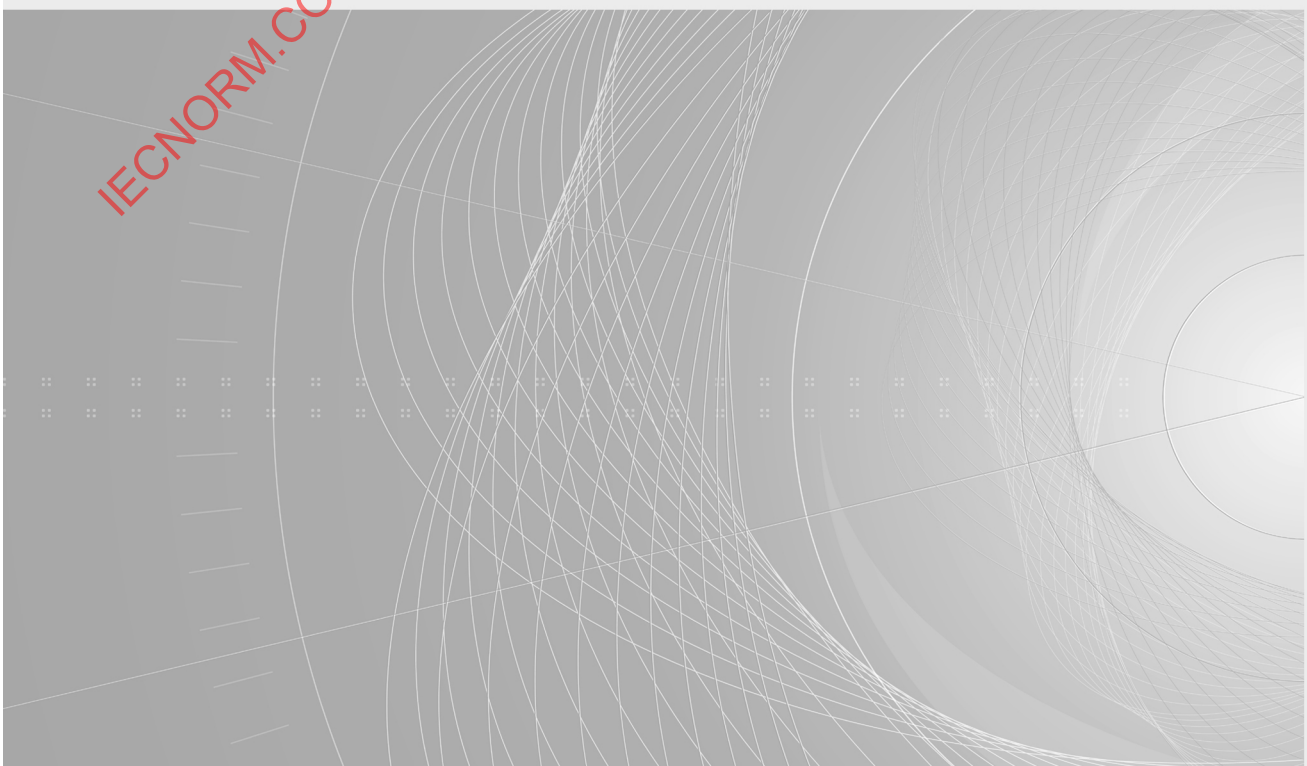
colour inside

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

Exigences de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire –
Partie 2-032: Exigences particulières pour les capteurs de courant, PORTATIFS et manipulés manuellement, pour essai électrique et mesurage



IEC 61010-2-032:2019-06(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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

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.
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International Standard IEC 61010-2-032 has been prepared by IEC technical committee 66: Safety of measuring, control and laboratory equipment.

This fourth edition cancels and replaces the third edition published in 2012. This edition constitutes a technical revision.

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

a) It has been indicated that current sensors used as FIXED EQUIPMENT are not within the scope of this document.
b) Fork-style current sensors have been added.

c) Requirements from Part 2-033 applicable to CLAMP MULTIMETERS that have a primary purpose of measuring voltage on live MAINS have been included in the new normative Annex EE.

d) CLEARANCES and CREEPAGE DISTANCES for measuring circuit TERMINALS exceeding 1 000 V a.c. or 1 414 V d.c. and for WET LOCATIONS have been specified.

e) Reduced CREEPAGE DISTANCES are allowed to be according to material group I for all insulating materials.

f) Requirements for input/output circuits of Type A, Type B and Type C current sensors have been detailed in 6.9.102.

g) Requirements for output circuit leads have been modified.

h) The JAW impact test has been limited to the front of the JAWS.

i) The abrasion test for cords of flexible current sensors has been removed and replaced by a pressure test at high temperature.

j) The voltage source for testing overvoltage limiting components or circuits may be limited to 400 V.

k) Reference to IEC 61010-031 for probe assemblies has been added.

l) Requirements for the prevention of TRANSIENT OVERVOLTAGES for MAINS voltage measuring circuits have been added.

m) Requirements for measuring circuits from 1 000 V to 3 000 V have been added.

n) An informative Annex CC about the dimensions of banana TERMINALS has been added.

o) A flowchart for insulation according to the type of circuit has been added in a new Annex DD.

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

FDIS	Report on voting
66/691/FDIS	66/695/RVD

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

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

A list of all parts of the IEC 61010 series, under the general title *Safety requirements for electrical equipment for measurement, control, and laboratory use*, can be found on the IEC website.

This Part 2-032 is to be used in conjunction with the latest edition of IEC 61010-1. It was established on the basis of the third edition (2010) of IEC 61010-1 and its Amendment 1 (2016), hereinafter referred to as Part 1.

This Part 2-032 supplements or modifies the corresponding clauses in IEC 61010-1 so as to convert that publication into the IEC standard: *Particular requirements for HAND-HELD and hand-manipulated current sensors for electrical test and measurement.*

Where a particular subclause of Part 1 is not mentioned in this Part 2-032, that subclause applies as far as is reasonable. Where this Part 2-032 states "addition", "modification", "replacement", or "deletion" the relevant requirement, test specification or note in Part 1 should be adapted accordingly.

In this standard:

a) the following print types are used:
   - requirements: in roman type;
   - NOTES: in small roman type;
   - *conformity and tests: in italic type;*
   - terms used throughout this standard which have been defined in Clause 3: SMALL ROMAN CAPITALS;

b) subclauses, figures, tables and notes which are additional to those in Part 1 are numbered starting from 101. Additional annexes are lettered starting from AA and additional list items are lettered from aa).

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

The contents of the corrigendum of February 2020 have been included in this copy.

INTRODUCTION

Part 2-030 specifies the safety requirements for equipment with testing and measuring circuits which are connected for test or measurement purposes to devices or circuits outside the measurement equipment itself. Requirements of Part 2-030 have been included in this Part 2-032. Equipment within the scopes of both Part 2-030 and Part 2-032 are considered to be covered by the requirements of this Part 2-032.

Part 2-033 specifies the safety requirements for hand-held multimeters that have the primary purpose of measuring voltage on live MAINS. For equipment within the scope of Part 2-032 and Part 2-033, only this Part 2-032 is applicable.

Part 2-034 specifies the safety requirements for measurement equipment for insulation resistance and test equipment for electric strength which are connected to units, lines or circuits for test or measurement purposes. For equipment within the scope of Part 2-032 and Part 2-034, both documents should be read in conjunction.

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

1 Scope and object

This clause of Part 1 is applicable except as follows:

1.1.1 Equipment included in scope

Replace the existing text with the following:

This part of IEC 61010 specifies safety requirements for HAND-HELD and hand-manipulated current sensors described below.

These current sensors are for measuring, detecting or injecting current, or indicating current waveforms on circuits without physically opening the current path of the circuit being measured. They can be stand-alone current sensors or accessories to other equipment or parts of combined equipment (see Figure 101). These include measurement circuits which are part of electrical test and measurement equipment, laboratory equipment, or process control equipment. These current sensors and circuits need additional protective means between the current sensor, the circuit and an OPERATOR.

NOTE 1 Combined equipment is equipment that is electrically connected to a current sensor by means of a permanent connection which can be detached only by the use of a TOOL.

NOTE 2 Some current sensors are also known as current clamps, CLAMP MULTIMETERS and current probes.

Current sensors are hand-manipulated before and/or after a test or measurement, but do not necessarily need to be HAND-HELD during the test or measurement. Current sensors used as FIXED EQUIPMENT are not within the scope of this document.

The following types of current sensors are covered:

a) Type A: a current sensor designed to be applied to or removed from HAZARDOUS LIVE UNINSULATED CONDUCTORS. Type A current sensors have defined HAND-HELD or hand-manipulated parts providing protection against electric shock from the conductor being measured, and also have protection against short-circuits between wires and between busbars during clamping.

b) Type B: a current sensor which has protection against short-circuits between wires or busbars during clamping but without defined HAND-HELD or hand-manipulated parts which provide protection against electric shock during clamping. Additional protective means are necessary to avoid electric shock from HAZARDOUS LIVE conductors which cannot be de-energised during application or removal of the current sensor.

EXAMPLE 1 Flexible current sensors.

c) Type C: a current sensor without protection against short-circuits between wires or busbars during clamping. Type C current sensors are intended to be applied to or removed from HAZARDOUS LIVE UNINSULATED CONDUCTORS or from non-limited-energy circuit conductors only when they are de-energised.

EXAMPLE 2 Split-core transducers.

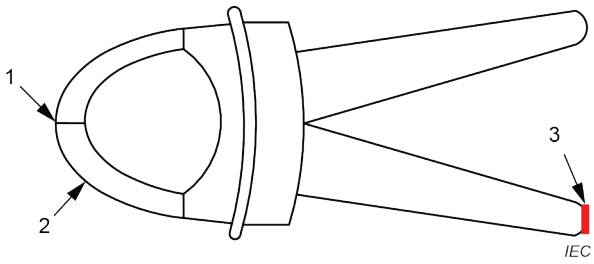
d) Type D: a current sensor designed to be applied to or removed from insulated conductors or from limited-energy circuit conductors.

EXAMPLE 3 Current probes for oscilloscopes and earth leakage current detectors.

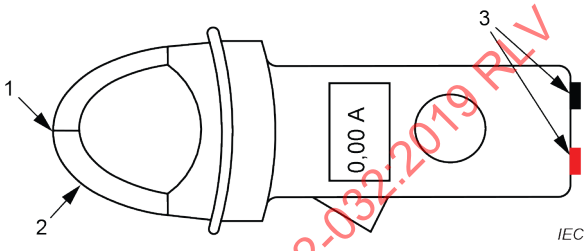
All current sensors can also be used with insulated conductors. In this case, HAZARDS are limited to acceptable levels by the insulation of the conductors.

Additional requirements for CLAMP MULTIMETERS are given in Annex EE.

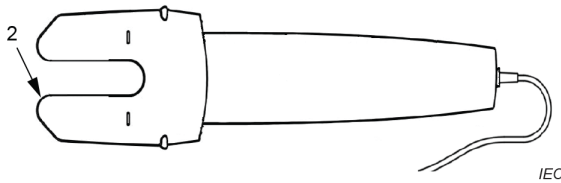
Figure 101 shows graphical representations of typical current sensors for illustration purposes. Current sensors can look different depending on the design.



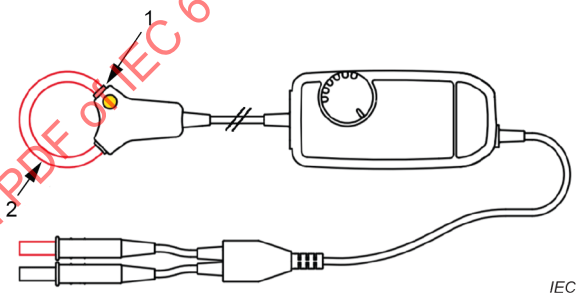
Type A current sensor as an accessory



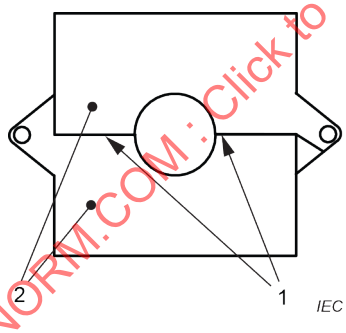
Type A current sensor with self-contained and/or additional measuring functions



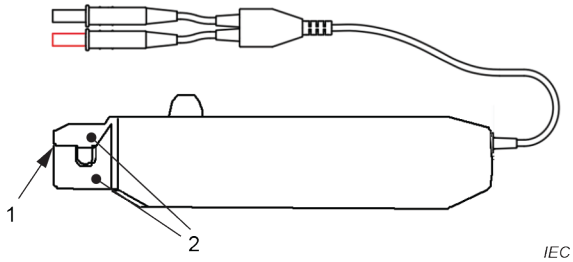
Type A current sensor with fork-style JAWS



Type B flexible current sensor part of a piece of combined equipment



Type C split-core current sensor



Type D current sensor for non-HAZARDOUS LIVE applications (shown with a sliding JAW)

Key

1 JAW END(S)

2 JAW

3 Measuring circuit TERMINALS

Figure 101 – Examples of current sensors and their parts

1.2.1 Aspects included in scope

Add the following three new paragraphs at the end of the subclause:

Requirements for protection against HAZARDS resulting from NORMAL USE and REASONABLY FORESEEABLE MISUSE of measuring circuits are given in Clause 101.

Requirements for prevention of HAZARD from arc flash and short-circuits are given in Clause 102.

Requirements for reliance on the displayed value of CLAMP MULTIMETERS are given in Clause EE.5 .

2 Normative references

This clause of Part 1 is applicable except as follows:

Replace "IEC 61010-031" with the following new reference:

IEC 61010-031:2015, *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 61010-031:2015/AMD1:2018

Replace "IEC 61180-1 (all parts)", "IEC 61180-1" and "IEC 61180-2", with the following new reference:

IEC 61180, *High-voltage test techniques for low-voltage equipment – Definitions, test and procedure requirements, test equipment*

3 Terms and definitions

This clause of Part 1 is applicable except as follows:

3.1 Equipment and states of equipment

Add the following two new terms and definitions:

3.1.101
HAND-HELD
intended to be supported by one hand during NORMAL USE

3.1.102
CLAMP MULTIMETER
HAND-HELD multi-range and multifunction measuring instrument intended to measure current on a live MAINS without physically opening the conductors, voltage on a live MAINS and other electrical quantities such as resistance

3.2 Parts and accessories

Add the following two new terms and definitions:

3.2.101
JAW
part of a current sensor which surrounds or partially surrounds the conductor under test

3.2.102
JAW END
part of the JAW where opening occurs while clamping around a conductor

3.5 Safety terms

Replace the definition of 3.5.4 with the following new definition:

3.5.4
MAINS
electricity supply system

Add the following new term and definition:

3.5.101
MEASUREMENT CATEGORY
classification of testing and measuring circuits according to the type of MAINS to which they are intended to be connected

Note 1 to entry: MEASUREMENT CATEGORIES take into account OVERVOLTAGE CATEGORIES, short-circuit current levels, the location in the building installation where the test or measurement is to be made and some forms of energy limitation or transient protection included in the building installation. See Annex AA for more information.

3.6 Insulation

Add the following new term and definition:

3.6.101
UNINSULATED CONDUCTOR
conductor not insulated by solid insulation or insulated by solid insulation which does not meet the requirements for BASIC INSULATION for the relevant voltage to earth

4 Tests

This clause of Part 1 is applicable except as follows:

4.3.2.5 MAINS supply

Replace the existing title and text with:

4.3.2.5 Power supply

The following requirements apply.

a) The MAINS supply voltage shall be between 90 % and 110 % of any RATED supply voltage for which the equipment can be set or, if the equipment is RATED for a greater fluctuation, at any supply voltage within the fluctuation range.

b) The MAINS frequency shall be any RATED frequency.

c) Equipment for both a.c. and d.c. shall be connected to an a.c. or d.c. supply.

d) Equipment powered by single-phase a.c. MAINS supply shall be connected both with normal and reverse polarity.

e) If the means of connection permit reversal, battery-operated and d.c. equipment shall be connected with both reverse and normal polarity.

4.3.2.6 Input and output voltages

Replace the existing title and text with:

4.3.2.6 Input and output voltages or currents

Input and output voltages or currents, including floating voltages but excluding the MAINS supply voltage, shall be set to any voltage or current within their RATED range, in normal and reverse polarity if possible.

4.4.2.8 Outputs

Replace the text with the following:

Outputs shall be open-circuited and short-circuited, one at a time.

5 Marking and documentation

This clause of Part 1 is applicable except as follows:

5.1.2 Identification

Add the following new items and a new paragraph after the note to item b):

aa) for current sensors designed for use only with a specific model of equipment, a clear identification of the equipment, or with symbol 14 of Table 1 if this information is available only in the documentation;

bb) for Type A current sensors, with symbol 102 of Table 1;

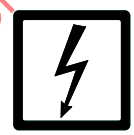
cc) for Type B and Type C current sensors, with symbol 101 of Table 1;

dd) for Type D current sensors, with symbol 101 and symbol 14 of Table 1.

The relevant symbol (14, 101 or 102) shall be marked adjacent to the JAWS or to the marking of the MEASUREMENT CATEGORY for the JAWS, if present (see 5.1.5.101 and 5.1.5.102).

Table 1 – Symbols

Add the following two new symbols:

Number	Symbol	Reference	Description
101			Do not apply current sensor to or remove from HAZARDOUS LIVE UNINSULATED CONDUCTORS, which may render electric shock, electric burn, or arc flash
102		IEC 60417-6300 (2016-03)	Application of current sensor to and removal from HAZARDOUS LIVE UNINSULATED CONDUCTORS is permitted

5.1.5 TERMINALS, connections and operating devices

Add the following two new subclauses:

5.1.5.101 Measuring circuit TERMINALS

5.1.5.101.1 General

Except as permitted in 5.1.5.101.4:

a) the value of the RATED voltage to earth of measuring circuit TERMINALS shall be marked, and

b) the value of the RATED voltage or the RATED current, as applicable, of each pair or set of measuring circuit TERMINALS that are intended to be used together shall be marked, and

c) the pertinent MEASUREMENT CATEGORY for each individual, pair, or set of measuring circuit TERMINALS, or symbol 14 of Table 1 shall be marked as specified in 5.1.5.101.2 and 5.1.5.101.3, if applicable.

Measuring circuit TERMINALS are usually arranged in pairs or sets. Each pair or set of TERMINALS may have a RATED voltage or a RATED current, or both, within that set, and each individual TERMINAL may have a RATED voltage to earth. For some current sensors, the RATED voltage between TERMINALS may be different from the RATED voltage to earth. Markings shall be clear to avoid misunderstanding.

Markings shall be placed adjacent to the TERMINALS. However, if there is insufficient space (as in multi-input current sensors), the marking may be on the RATING plate or scale plate, or the TERMINAL may be marked with symbol 14 of Table 1.

For any set of measuring circuit TERMINALS, symbol 14 of Table 1 does not need to be marked more than once, if it is close to the TERMINALS.

Conformity is checked by inspection and, if applicable, as specified in 5.1.5.101.2 *and* 5.1.5.101.3*, taking the exceptions in* 5.1.5.101.4 *into account.*

5.1.5.101.2 Measuring circuit TERMINALS rated for MEASUREMENT CATEGORIES

The relevant MEASUREMENT CATEGORY shall be marked for TERMINALS of measuring circuits RATED for MEASUREMENT CATEGORIES. The MEASUREMENT CATEGORY markings shall be "CAT II", "CAT III" or "CAT IV" as applicable.

Marking those TERMINALS with more than one type of MEASUREMENT CATEGORY and its RATED voltage to earth is permissible.

Conformity is checked by inspection.

5.1.5.101.3 Measuring circuit TERMINALS RATED for connection to voltages above the levels of 6.3.1

Symbol 14 of Table 1 shall be marked for measuring circuit TERMINALS RATED for connection to voltages above the levels of 6.3.1, but that are not RATED for MEASUREMENT CATEGORIES (see also 5.4.2 bb)).

Conformity is checked by inspection.

5.1.5.101.4 Measuring circuit TERMINALS which are permanently connected, dedicated or for non-HAZARDOUS LIVE voltages

Measuring circuit TERMINALS do not need to be marked if:

a) they are intended to be permanently connected and not ACCESSIBLE (see 5.4.3 aa) and bb)), or

b) they are dedicated only for connection to specific TERMINALS of other equipment (see also 6.101.3), or

c) it is obvious from other indications that the RATED voltage is below the levels of 6.3.1.

NOTE Examples of acceptable indications that the inputs are intended to be less than the levels of 6.3.1 include:

– the full scale deflection marking of a single-range indicating voltmeter or ammeter;

– the maximum range marking of a voltage selector switch;

– a marked voltage or power RATING expressed in dB, mW or W, where the equivalent value, as explained in the documentation, is below 30 V a.c.

Conformity is checked by inspection.

5.1.5.102 Voltage and current RATINGS of JAWS

Current sensors that are intended to be used on UNINSULATED CONDUCTORS shall be marked with the value of the RATED voltage to earth of the JAWS.

JAWS of Type A, Type B or Type C current sensors RATED for MEASUREMENT CATEGORIES, shall be marked with the relevant MEASUREMENT CATEGORY adjacent to the voltage to earth marking. The MEASUREMENT CATEGORY markings shall be "CAT II", "CAT III" or "CAT IV" as applicable.

JAWS and output circuit TERMINALS of Type D current sensors shall not be marked with any MEASUREMENT CATEGORY.

The value of the RATED current shall be marked on or close to the JAWS. The nature of the current shall also be marked unless the marked value applies to both a.c. and d.c.

Conformity is checked by inspection.

5.4.1 General

Add the following new items to the list and a new paragraph:

aa) information about each relevant MEASUREMENT CATEGORY if the measuring circuit is RATED for MEASUREMENT CATEGORIES (see 5.1.5.101.2);

bb) for measuring circuits that are not RATED for MEASUREMENT CATEGORIES, but that could be misused by connection to such circuits, a warning not to use the current sensor for measurements on MAINS, and a detailed RATING including TRANSIENT OVERVOLTAGES (see AA.2.4 for more information).

Some current sensors may have multiple MEASUREMENT CATEGORY RATINGS for the same measuring circuit. For such current sensors, the documentation shall clearly identify the MEASUREMENT CATEGORIES where the current sensor is intended to be used and where it shall not be used.

5.4.2 Equipment RATINGS

Add the following two new items to the list and a new paragraph:

aa) information about each relevant MEASUREMENT CATEGORY if the measuring circuit is RATED for MEASUREMENT CATEGORIES (see 5.1.5.101.2 and 5.1.5.102);

bb) for Type A, Type B and Type C current sensors that are not RATED for MEASUREMENT CATEGORIES, but that could be misused by connection to such circuits, a warning not to use the current sensor for measurements on MAINS, and a detailed RATING including TRANSIENT OVERVOLTAGES (see AA.2.4 for more information).

If the current sensor has multiple MEASUREMENT CATEGORY RATINGS for the same measuring circuit, the documentation shall clearly identify the MEASUREMENT CATEGORIES where the current sensor is intended to be used and where it shall not be used.

5.4.3 Equipment installation

Add the following two new items to the list:

aa) for measuring circuit TERMINALS intended for permanent connection and that are RATED for MEASUREMENT CATEGORIES, information regarding the MEASUREMENT CATEGORY, RATED voltages or RATED currents as applicable (see 5.1.5.101.2 and 5.1.5.102);

bb) for measuring circuit TERMINALS intended for permanent connection and that are not RATED for MEASUREMENT CATEGORIES, information regarding the RATED voltages, RATED currents, and RATED TRANSIENT OVERVOLTAGES as applicable (see 5.1.5.101.4 and 5.1.5.102).

5.4.4 Equipment operation

Replace the existing text with the following:

Instructions for use shall include, if applicable:

a) identification and description of operating controls and their use in all operating modes;

b) for current sensors designed for use only with a specific model of equipment, a clear identification of the equipment;

c) specifications of limits for intermittent operation;

d) specifications of limits of the current versus the frequency if the magnetic circuit can reach a hazardous temperature;

e) explanations of symbols related to safety which are used on the current sensor;

f) instructions for interconnection to accessories and other equipment, including indication of suitable accessories and detachable parts;

g) instructions for replacement of consumable materials;

h) instructions for cleaning and decontamination;

i) instructions for the application and removal of the current sensor;

j) instructions to de-energise the installation on which the current is measured, or to adopt safe operating procedures when working on HAZARDOUS LIVE installations, during application and removal of Type B current sensors;

k) instructions to de-energise the installation on which the current is measured, when working on HAZARDOUS LIVE installations, or non-limited-energy installations during application and removal of Type C current sensors;

l) instructions about the function of the PROTECTIVE BARRIER, indicating the limit of safe access of the HAND-HELD part;

m) a warning to the OPERATOR that Type D current sensors are only for use around insulated conductors or limited energy circuit conductors;

n) a warning to the OPERATOR that individual protective equipment should be used if HAZARDOUS LIVE parts in the installation where measurement is to be carried out could be ACCESSIBLE;

o) a warning to the OPERATOR not to use a flexible current sensor if the wear indicator of the flexible cord used for the JAW of the flexible current sensor is visible (see 8.103);

p) a warning to the OPERATOR not to use a current sensor if the wear indicator in the JAW END is visible (see 8.104);

q) a warning to the OPERATOR not to use a current sensor above its RATED frequency, if the magnetic circuit can reach a hazardous temperature (see 10.101).

There shall be a statement in the instructions that, if the current sensor is used in a manner not specified by the manufacturer, the protection provided by the current sensor may be impaired.

Conformity is checked by inspection.

6 Protection against electric shock

This clause of Part 1 is applicable except as follows:

6.1.2 Exceptions

Add the following new item to the list:

aa) conductive parts of a JAW END, provided that they meet the requirements of 6.9.101.

6.5.2 PROTECTIVE BONDING

Replace the existing title with the following and delete the text:

6.5.2 Not used

6.6 Connections to external circuits

Add the following two new subclauses:

6.6.101 Measuring circuit TERMINALS

The conductive parts of each unmated measuring circuit TERMINAL which could become HAZARDOUS LIVE when the highest RATED voltage is applied to other measuring circuit TERMINALS on the current sensor shall be separated by at least:

a) for TERMINALS with voltage RATING up to 1 000 V a.c. or 1 500 V d.c., the applicable CLEARANCE and CREEPAGE DISTANCE of Table 101 from the closest approach of the test finger touching the external parts of the TERMINAL in the least favourable position (see Figure 1);

b) for TERMINALS with voltage RATING exceeding 1 000 V a.c. or 1 500 V d.c., 2,8 mm for the CLEARANCE and CREEPAGE DISTANCE from the closest approach of the test finger touching the external parts of the TERMINAL in the least favourable position. These TERMINALS shall also withstand the voltage test of 6.8 with a test voltage equal to the RATED voltage of the TERMINAL multiplied by 1,25 applied between the closest approach of the test finger touching the external parts of the TERMINAL in the least favourable position and the other measuring circuit TERMINALS.

EXAMPLE For a 4 000 V a.c. r.m.s. RATED voltage, the test voltage is 5 000 V a.c. r.m.s. (7 070 V peak). The calculated CLEARANCE is 13,1 mm according to D_2 in Table K.15. For homogeneous fields, a lower CLEARANCE value can be achieved by testing (see IEC 60664-1 for more information about homogeneous fields).

c) for WET LOCATIONS, there are no CLEARANCE and CREEPAGE DISTANCE requirements for voltages between 16 V a.c. r.m.s. and 30 V a.c. r.m.s., or between 35 V d.c. and 60 V d.c., but conductive parts of unmated measuring circuit TERMINALS shall not be ACCESSIBLE.

Table 101 – CLEARANCES and CREEPAGE DISTANCES for measuring circuit TERMINALS with HAZARDOUS LIVE conductive parts up to 1 000 V a.c. or 1 500 V d.c.

Voltage on conductive parts of TERMINAL V a.c. r.m.s. and V d.c.	CLEARANCE and CREEPAGE DISTANCE mm
≥ 30 ≤ 300	0,8
> 300 ≤ 600	1,0
> 600 ≤ 1 000	2,6
> 1 000 ≤ 1 500 [a]	2,8
NOTE The values in this table are not applicable to voltages below HAZARDOUS LIVE voltages (see 6.3.1 a)). [a] Only for d.c. voltage.	

Annex CC provides information regarding the recommended dimensions of 4 mm "banana" TERMINALS.

Conformity is checked by inspection, by the determination of ACCESSIBLE parts, by measurement of the applicable CLEARANCES and CREEPAGE DISTANCES, and if applicable, by the voltage test of 6.8.

6.6.102 Specialized measuring circuit TERMINALS

Components, sensors, and devices intended to be connected to specialized measuring circuit TERMINALS shall not be both ACCESSIBLE and HAZARDOUS LIVE, in either NORMAL CONDITION or in SINGLE-FAULT CONDITION, even when the highest RATED voltage is applied to any other measuring circuit TERMINAL.

NOTE These specialized TERMINALS include, but are not limited to, TERMINALS for semiconductor measuring functions, capacitance measurements, and thermocouple sockets.

Conformity is checked by inspection and measurement. Components, sensors, and devices intended to be connected to specialized measuring circuit TERMINALS are connected. The measurements of 6.3 are made to establish that the levels of 6.3.1 and 6.3.2 are not exceeded when each of the following voltages is applied to each other measuring circuit TERMINAL, if applicable:

a) highest RATED a.c. voltage at any RATED MAINS frequency;

b) highest RATED d.c. voltage;

c) highest RATED a.c. voltage at the related maximum RATED measurement frequency.

6.7.1.3 CREEPAGE DISTANCES

Add the following new paragraph after the third paragraph:

For HAND-HELD EQUIPMENT not powered from the MAINS or the measuring circuit, CREEPAGE DISTANCES according to material group I are allowed to be used for other materials.

For TERMINALS of HAND-HELD EQUIPMENT intended to be connected only to a HAND-HELD probe assembly complying with Part 031, CREEPAGE DISTANCES according to material group I are allowed to be used for the insulating material of the TERMINALS.

6.7.1.5 Requirements for insulation according to type of circuit

Replace the text with the following:

Requirements for insulation in particular types of circuits are specified as follows:

a) in 6.7.2 for MAINS CIRCUITS of OVERVOLTAGE CATEGORY II with a nominal supply voltage up to 300 V;

NOTE 1 See Annex I for nominal voltages of MAINS supplies.

b) in 6.7.3 for secondary circuits separated from the circuits in a) only by means of a transformer;

c) in Clause K.1 for MAINS CIRCUITS of OVERVOLTAGE CATEGORY III or IV or for OVERVOLTAGE CATEGORY II over 300 V;

d) in Clause K.2 for secondary circuits separated from the circuits in c) only by means of a transformer;

e) in Clause K.3 for circuits that have one or more of the following characteristics:

1) the maximum possible TRANSIENT OVERVOLTAGE is limited by the supply source or within the current sensor to a known level below the level assumed for the MAINS CIRCUIT;

2) the maximum possible TRANSIENT OVERVOLTAGE is above the level assumed for the MAINS CIRCUIT;

3) the WORKING VOLTAGE is the sum of voltages from more than one circuit, or is a mixed voltage;

4) the WORKING VOLTAGE includes a recurring peak voltage that may include a periodic non-sinusoidal waveform or a non-periodic waveform that occurs with some regularity;

5) the WORKING VOLTAGE has a frequency above 30 kHz;

6) the circuit is a measuring circuit where MEASUREMENT CATEGORIES do not apply.

f) in Clause K.101 for measuring circuits RATED for MEASUREMENT CATEGORIES.

NOTE 2 These requirements are illustrated in the flowchart of Annex DD, Figure DD.1.

The TRANSIENT OVERVOLTAGE level for the MAINS corresponds to the "required RATED impulse voltage of equipment" value specified in Table 443.2 of IEC 60364-4-44:2007/AMD1:2015.

6.8.3.1 The a.c. voltage test

Replace the first sentence with the following sentence:

The voltage tester shall be capable of maintaining the test voltage throughout the test within ±5 % of the specified value.

6.9 Constructional requirements for protection against electric shock

Add the following two new subclauses:

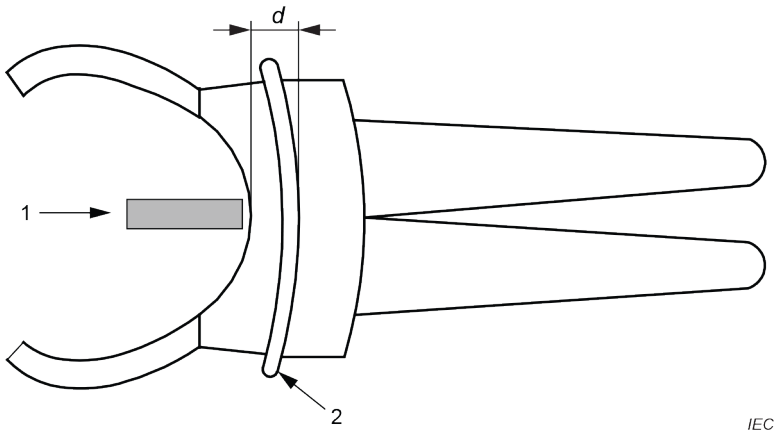
6.9.101 Protection against the HAZARDOUS LIVE conductor

6.9.101.1 Protection by a PROTECTIVE BARRIER

To reduce the RISK of the OPERATOR touching the HAZARDOUS LIVE conductor during clamping or measurement, Type A current sensors shall have a PROTECTIVE BARRIER to warn the OPERATOR of the limit of safe access. The PROTECTIVE BARRIER shall cover at least 50 % of the perimeter, and shall at least extend along two opposite sides of the HAND-HELD part.

The CLEARANCE and CREEPAGE DISTANCE between HAZARDOUS LIVE parts and the PROTECTIVE BARRIER shall meet the requirements for REINFORCED INSULATION for the RATING of the JAWS. Figure 102 gives an example of the CLEARANCE "*d*" from the PROTECTIVE BARRIER to the JAWS and to the HAZARDOUS LIVE conductor.

Conformity is checked by inspection and measurement of CLEARANCES and CREEPAGE DISTANCES.



Key

1 HAZARDOUS LIVE conductor

2 PROTECTIVE BARRIER

d Distance between PROTECTIVE BARRIER and HAZARDOUS LIVE conductor

Figure 102 – CLEARANCE between the PROTECTIVE BARRIER to the JAWS and to the HAZARDOUS LIVE conductor

6.9.101.2 HAND-HELD or hand-manipulated parts

HAND-HELD or hand-manipulated parts of Type A current sensors shall be separated by DOUBLE INSULATION or REINFORCED INSULATION from the parts of the JAWS which can be touched by an UNINSULATED CONDUCTOR, in open and in closed position. If any conductive part of the magnetic circuit can touch a conductor, it is considered to be held at the RATED voltage to earth of the JAWS.

JAW ENDS which have a wear indicator shall provide at least DOUBLE INSULATION or REINFORCED INSULATION when new, and at least BASIC INSULATION when the wear indicator becomes visible.

Conformity is checked by inspection, by determination of the touchable parts of the JAWS in open and in closed position using the metal pin of 6.2.3 and determination of the ACCESSIBLE HAND-HELD or hand-manipulated parts, and,

a) if the current sensor is RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.101.2 and K.101.3, and for solid insulation by the applicable tests of K.101.4;

b) if the current sensor is not RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.3.2 or K.3.3 and K.3.4, and for solid insulation by the applicable tests of K.3.5.

NOTE The metal test pin simulates an UNINSULATED CONDUCTOR.

In addition to the metal pin, the outer surfaces of the ENCLOSURE of the JAWS are covered with metal foil in open and in closed position during the test.

If the JAW ENDS of Type A current sensors RATED for MEASUREMENT CATEGORIES III and IV, include a wear indicator, measurement and tests are done both before and after the JAW ENDS abrasion test of 8.101 and the JAW impact test of 8.102, if applicable.

If the JAW ENDS do not include a wear indicator, measurement and tests are done after the JAW ENDS abrasion test of 8.101 and the JAW impact test of 8.102, if applicable.

6.9.102 Input/output circuits

Input/output circuits of Type A, Type B and Type C current sensors shall be separated by DOUBLE INSULATION or REINFORCED INSULATION from the parts of the JAWS which can be touched by an UNINSULATED CONDUCTOR, in open and in closed position. If any conductive part of the magnetic circuit can touch a conductor, it is considered to be held at the RATED voltage to earth of the JAWS.

JAW ENDS which have a wear indicator shall provide at least DOUBLE INSULATION or REINFORCED INSULATION when new, and at least BASIC INSULATION when the wear indicator becomes visible.

Conformity is checked by inspection, by determination of the touchable parts of the JAWS in open and in closed position using the metal pin of 6.2.3, and,

a) if the current sensor is RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.101.2 and K.101.3, and for solid insulation by the applicable tests of K.101.4;

b) if the current sensor is not RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.3.2 or K.3.3 and K.3.4, and for solid insulation by the applicable tests of K.3.5.

NOTE The metal test pin simulates an UNINSULATED CONDUCTOR.

In addition to the metal pin, the outer surfaces of the ENCLOSURE of the JAWS are covered with metal foil in open and in closed position.

If the JAW ENDS include a wear indicator, measurement and tests are done both before and after the JAW ENDS abrasion test of 8.101 and the JAW impact test of 8.102, if applicable.

If the JAW ENDS do not include a wear indicator, measurement and tests are done after the JAW ENDS abrasion test of 8.101 and the JAW impact test of 8.102, if applicable.

Add the following new subclause:

6.101 Output circuit leads

6.101.1 General

The outer surfaces of output circuit leads of current sensors can easily touch HAZARDOUS LIVE parts of the installation under test. The inner conductors of output circuit leads of current sensors can also be held at a HAZARDOUS LIVE voltage when connected to measuring or control equipment (wattmeter, power quality analyser, etc.).

6.101.2 Connection to the current sensor ENCLOSURE body

The mated TERMINALS located at the current sensor ENCLOSURE body and/or the leads shall have DOUBLE INSULATION or REINFORCED INSULATION between their outer surfaces and their conductors.

For Type A, Type B and Type C current sensors, the insulation of the output circuit leads and the mated TERMINALS is based on the requirements of Clause K.101 for the higher of the voltage RATING and the MEASUREMENT CATEGORY RATING of the JAWS or this RATING of the output circuit but not less than 300 V in MEASUREMENT CATEGORY II.

For Type D current sensors, the insulation of the output circuit leads and of the mated TERMINALS is based on the requirements of Clause K.101 for 300 V in MEASUREMENT CATEGORY II.

Conformity is checked by inspection, by measurement of the applicable values of CLEARANCES and CREEPAGE DISTANCES of K.101.2 and by the applicable tests of K.101.4 for solid insulation.

6.101.3 Connection to measuring or control equipment

The manufacturer shall assign a voltage value and specify if a MEASUREMENT CATEGORY is RATED for this connection.

No minimum voltage RATINGS are required by this document for the current sensor TERMINALS dedicated for connection to measuring or control equipment.

The unmated TERMINALS shall comply with the requirements of 101.2.

If the current sensor has been designed for use only with a specific model of equipment, the current sensor TERMINAL RATING shall be consistent with the TERMINAL RATING of this specific measuring or control equipment.

Conformity is checked as specified in 101.2, by inspection, and,

a) if the current sensor is RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.101.2 and K.101.3, and for solid insulation by the applicable tests of K.101.4;

b) if the current sensor is not RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.3.2 or K.3.3 and K.3.4, and for solid insulation by the applicable tests of K.3.5.

7 Protection against mechanical HAZARDS

This clause of Part 1 is applicable.

8 Resistance to mechanical stresses

This clause of Part 1 is applicable except as follows:

Add the following four new subclauses:

8.101 JAW ENDS abrasion test

When current sensors are applied to or removed from conductors, their JAW ENDS can be submitted to abrasion, in particular when the conductor is a busbar. These current sensors shall be designed to be safe after the following JAW ENDS abrasion test, performed to simulate the wear of the JAWS during insertion and removal. This requirement is applicable only to Type A and Type B current sensors RATED for MEASUREMENT CATEGORIES III and IV. Current sensors with a sliding JAW, current sensors with fork-style JAWS and flexible current sensors are not concerned by 8.101.

JAW ENDS can have a wear indicator to view the limit of use after abrasion. A wear indicator is a feature with a contrasting colour designed to be not visible until a limit has been reached.

One unconditioned sample of the current sensor in NORMAL CONDITION and one preconditioned sample of the current sensor that has been conditioned as specified in 10.5.2 a) are treated as follows.

A plate is prepared consisting of a rigid material, covered on both sides by emery cloth. The plate is a minimum of 50 mm by 450 mm, with a thickness not exceeding 2 mm. The emery cloth shall be No. 120 grit, with aluminium oxide abrasive bound in an enclosed coating and with a cloth backing.

With the JAWS open, the samples are positioned as shown in Figure 103 and then the JAWS are closed.

The samples are moved along the plate over a distance of 200 mm, or a lesser amount if restricted by the design, for 50 cycles – one cycle consisting of one forward and one reverse movement – so as to abrade the closing point of the JAWS (see Figure 103). If the insulation of the JAW ENDS has a wear indicator, the test is terminated if the wear indicator becomes visible before 50 cycles are completed. The emery cloth is replaced after each sample has been treated.

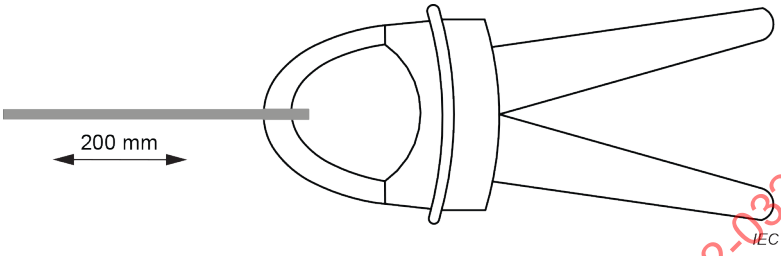


Figure 103 – Abrasion test of the JAW ENDS

After the abrasion test, the samples of current sensor are submitted to the conformity statement of 6.9.101.2 and 6.9.102.

8.102 Jaw impact test

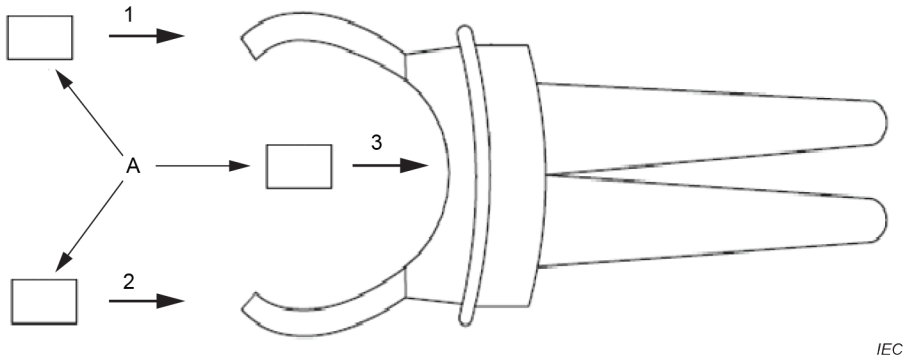
When current sensors are applied to or removed from conductors, they can hit them and be damaged, in particular when the conductor is a busbar. These current sensors shall be designed to be safe after the following JAW impact test, performed to simulate the stress of the JAWS during insertion. This requirement is applicable only to Type A current sensors RATED for MEASUREMENT CATEGORIES III and IV, except for flexible current sensors. The normal energy protection level required for impact is from Table 102.

The test is carried out on one sample of current sensor. The sample is tested according to IEC 60068-2-75 either by Eha (pendulum hammer) test, Ehb (spring hammer) test or Ehc (vertical hammer) test with an energy level determined from Table 102 according to the current sensor mass.

Table 102 – Energy level for JAW impact test

Current sensor mass kg	Energy level J	IK code (IEC 62262)
≤ 0,5	1	IK06
> 0,5 ≤ 1	2	IK07
> 1	5	IK08

The sample is cooled to the minimum RATED ambient temperature for at least 4 h, and then tested within 3 min. The sample is held firmly against a rigid support and opened as far as possible. Three points are tested, two of these are on the outer surfaces of the JAWS close to the JAW ENDS, and the third point is the inner surface of the sensor directly opposite the opening (see Figure 104). The number of impacts is one per point.



Key

A Hammer

1, 2, 3 Direction of impact

Figure 104 – Impact points for JAW impact test

After the JAW impact test, the sample of current sensor is returned to a reference test temperature (see 4.3.1) and submitted to the conformity statement of 6.9.101.2 and 6.9.102.

8.103 Pressure test at high temperature for insulation of flexible current sensors

Flexible cords used for the JAW of a flexible current sensor shall not cause a HAZARD when subjected to mechanical stress likely to occur in NORMAL USE. To achieve this requirement, flexible cords shall be designed to be safe after the following pressure test, performed to simulate the stress of the flexible cords during use.

Flexible cords can have a wear indicator to view the limit of use. A wear indicator is a feature with a contrasting colour designed to be not visible until a limit of wear has been reached.

Flexible cords shall provide at least DOUBLE INSULATION or REINFORCED INSULATION when new. In addition, they shall meet the following:

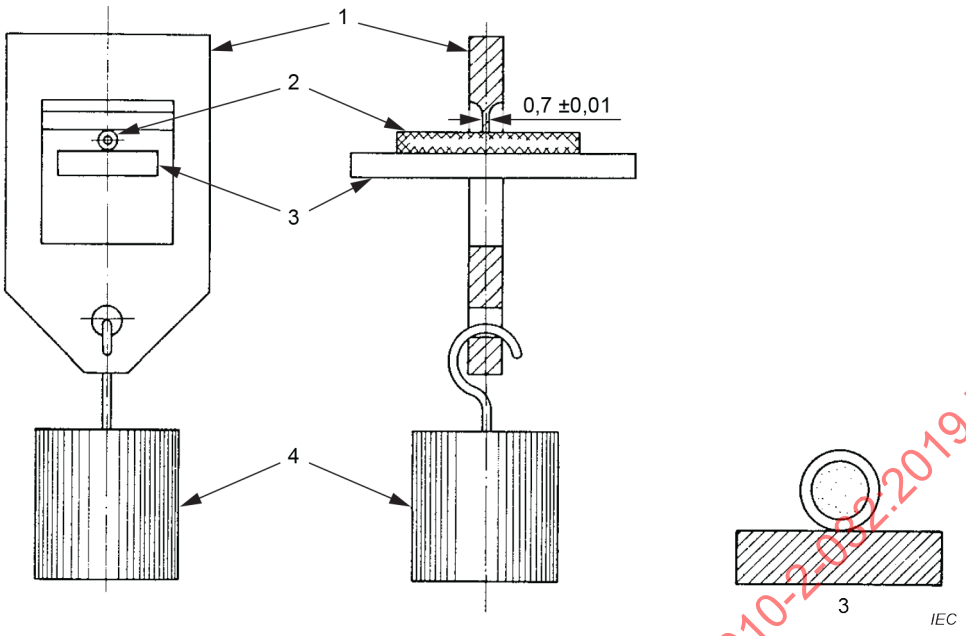
a) If they do not have a wear indicator, they shall provide at least DOUBLE INSULATION or REINFORCED INSULATION after typical lifetime wear.

b) If they have a wear indicator, they shall provide at least BASIC INSULATION when the wear indicator becomes visible.

Conformity is checked by the following tests:

Three samples of the flexible cord are tested. Each sample is taken from a flexible current sensor having a length of 150 mm to 300 mm. The length of each sample is 50 mm to 100 mm.

The indentation device is shown in Figure 105, and consists of a rectangular blade with an edge 0,70 mm ± 0,01 mm wide, which can be pressed against the sample. Each sample is placed in the position shown in Figure 105. A flat flexible cord without a sheath is laid on its flat side. Samples are fixed on the support in such a manner that they do not curve under the pressure of the blade. The force is applied in a direction perpendicular to the axis of the sample; the blade is also perpendicular to the axis of the sample.



Key

1 Testing frame

2 Sample

3 Supports

4 Weight

Figure 105 – Indentation device

The compressing force F which is exerted by the blade upon the sample is given by the formula:

$$F = 0{,}6 \times \sqrt{(2 \times d \times e - e^2)}$$

where:

F is in newtons

e is the mean value of the thickness of the insulation of the sample

d is the mean value of the outer diameter of the sample

e and d are both expressed in millimetres, to one decimal place, and measured on a thin slice cut from the end of the test piece.

The test is carried out in air (i.e. in an air oven). The temperature of the air is maintained continuously at a temperature of minimum 105 °C. The loaded samples are kept in the test position for 4 h. Following this, the samples are rapidly cooled; cooling may be carried out by spraying the samples with cold water on the spot where the blade is pressing. The samples are removed from the apparatus when they have cooled to a temperature where recovery of the insulation no longer occurs. The samples are then cooled further by immersion in cold water.

After this treatment, each sample of flexible cord is checked as specified by the applicable tests of K.101.4 (without humidity preconditioning) if they are RATED for MEASUREMENT CATEGORIES, or by the applicable tests of K.3.5 (without humidity preconditioning) if they are not RATED for MEASUREMENT CATEGORIES.

The voltage is applied between the internal conductors of the flexible cord and metal foil wrapped around the outer cord jacket. The BASIC INSULATION test voltage values are used if the contrasting colour of the wear indicator is visible. Otherwise, the REINFORCED INSULATION test voltage values are used.

8.104 Pull test for endcaps of flexible current sensors

The endcaps of a flexible cord used for the JAW of the flexible current sensor shall be securely fixed, so that they withstand any forces likely to occur in NORMAL USE.

Conformity is checked by inspection and the following test on each endcap.

With the endcap clamped so that it cannot move, the flexible cord is subjected to a steady axial pull force according to Table 103 for 1 min. After the pull, the insulation shall not have moved more than 2 mm. If the insulation has moved more than 2 mm, then the pull is repeated 15 more times with a duration of 15 s each time.

After the last pull:

a) the insulation shall not have moved more than 1 mm above the displacement from the first pull if it is subjected to 16 pulls;

b) CLEARANCES and CREEPAGE DISTANCES shall not have been reduced below the applicable values for REINFORCED INSULATION defined in K.101.2 *and* K.101.3 *if the current sensor is RATED for MEASUREMENT CATEGORIES, or shall not have been reduced below the applicable values given in K.3.2 or K.3.3 and K.3.4 if the current sensor is not RATED for MEASUREMENT CATEGORIES; and*

c) the current sensor shall pass the applicable tests for REINFORCED INSULATION defined in K.101.4 *(without humidity preconditioning) if it is RATED for MEASUREMENT CATEGORIES, or the applicable tests of K.3.5 (without humidity preconditioning) if it is not RATED for MEASUREMENT CATEGORIES.*

Table 103 – Pull forces for endcaps of flexible current sensors

Maximum diameter of the flexible cord mm	Pull force N
≤ 5	50
10	75
≥ 20	100
Linear interpolation is allowed.	

9 Protection against the spread of fire

This clause of Part 1 is applicable.

10 Equipment temperature limits and resistance to heat

This clause of Part 1 is applicable except as follows:

10.5 Resistance to heat

Add the following new subclause:

10.5.101 Resistance to heat of current sensors

The insulating material of JAWS surrounding a magnetic material which can overheat shall have adequate resistance to heat.

Conformity is checked by examination of material data. For rigid insulating materials, if the material data is not conclusive, one of the following tests is performed.

a) *A sample of the insulating material, at least 2,5 mm thick, is subjected to a ball-pressure test using the test apparatus in Figure 14. The test is made in a heating cabinet at the temperature measured as specified in 10.101 ± 2 °C, or at 105 °C ± 2 °C, whichever is higher. The part to be tested is supported so that its upper surface is horizontal, and the spherical part of the apparatus is pressed against this surface with a force of 20 N. After 1 h the apparatus is removed and the sample is cooled within 10 s to approximately room temperature by immersion in cold water. The diameter of the impression caused by the ball shall not exceed 2 mm.*

   NOTE 1 If necessary, the required thickness can be obtained by using two or more sections of the part.

   NOTE 2 See IEC 60695-10-2 for more information about this test.

b) *The Vicat softening test of ISO 306, method A120. The Vicat softening temperature shall be at least 105 °C.*

Add the following new subclause:

10.101 Other temperatures of current sensors

Most current sensors depend on inductive connection to the circuit being measured. The behaviour of the measuring circuit will, in these cases, depend on the frequency of the signal being measured. When the current sensor is used to measure currents at high frequency, circulating currents could cause significant heating within the magnetic circuit of the current sensor.

If a HAZARD could be caused by excessive temperature, easily touched surfaces shall not exceed the values of Table 19 and the temperature of the insulating material of windings shall not exceed the values of Table 20 when the current sensor measures the maximum current at the frequency which causes the highest temperature.

NOTE The PROTECTIVE BARRIER of the current sensor (see 6.9.101.1) is not considered to provide a protection against burns.

Conformity is checked by measurement as specified in 10.4.

11 Protection against HAZARDS from fluids and solid foreign objects

This clause of Part 1 is applicable.

12 Protection against radiation, including laser sources, and against sonic and ultrasonic pressure

This clause of Part 1 is applicable.

13 Protection against liberated gases and substances, explosion and implosion

This clause of Part 1 is applicable.

14 Components and subassemblies

This clause of Part 1 is applicable except as follows:

Add the following two new subclauses:

14.101 Circuits used to limit TRANSIENT OVERVOLTAGE in measuring circuits used to measure MAINS

If control of TRANSIENT OVERVOLTAGES is employed in a measuring circuit used to measure MAINS, the overvoltage limiting component or circuit shall have adequate strength to limit likely TRANSIENT OVERVOLTAGES.

Conformity is checked by applying five positive and five negative impulses with the applicable impulse voltage of Table 104, spaced up to 1 min apart, from a hybrid impulse generator (see IEC 61180). The generator produces an open-circuit voltage waveform of 1,2/50 μs, a short-circuit current waveform of 8/20 μs, with an output impedance (peak open-circuit voltage divided by peak short-circuit current) of 2 Ω for MEASUREMENT CATEGORIES III and IV or 12 Ω for MEASUREMENT CATEGORY II. Resistance may be added in series if needed to raise the impedance.

The test voltage is applied while the circuit is operating under conditions of NORMAL USE, in combination with the MAINS voltage between each pair of TERMINALS used to measure MAINS where voltage-limiting devices are present.

The MAINS voltage is the maximum RATED line-to-neutral voltage of the MAINS being measured. For measuring circuits RATED for MAINS line-to-neutral voltages above 400 V a.c. r.m.s. or d.c., the test may be performed with an available voltage source that has a line-to-neutral voltage of at least 400 V a.c. r.m.s. or d.c. The voltage source does not, in this case, need to match the measuring circuit RATING, but circuits RATED for a.c. shall be tested with an a.c. source, and circuits RATED for d.c. shall be tested with a d.c. source.

NOTE 1 The impulses are synchronized with the MAINS voltage phase, timed to occur at the peak of the MAINS voltage and to be of the same polarity, with a phase tolerance of ±10° (see IEC 61180).

NOTE 2 This test can be extremely hazardous. Explosion shields and other provisions can be used to protect personnel performing the test.

No HAZARD shall arise. The overvoltage limiting devices shall not rupture or overheat during the test. Tripping the circuit breaker of the MAINS installation is an indication of failure. If the results of the test are questionable or inconclusive, the test is to be repeated two more times.

Table 104 – Impulse voltages

Nominal a.c. r.m.s line-to-neutral or d.c. voltage of MAINS being measured V	Impulse voltage V peak		
	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV
≤ 50	500	800	1 500
>50 ≤ 100	800	1 500	2 500
> 100 ≤ 150	1 500	2 500	4 000
> 150 ≤ 300	2 500	4 000	6 000
> 300 ≤ 600	4 000	6 000	8 000
> 600 ≤ 1 000	6 000	8 000	12 000
> 1 000 ≤ 1 500	8 000	10 000	15 000
>1 500 ≤ 2 000	12 000	15 000	18 000
>2 000 ≤ 3 000	15 000	18 000	20 000
Values over 1 000 V are from IEC TS 62993:2017, Table 1.			

14.102 Probe assemblies and accessories

Probe assemblies and accessories within the scope of IEC 61010-031, shall meet the requirements thereof.

Conformity is checked by inspection.

15 Protection by interlocks

This clause of Part 1 is applicable.

16 HAZARDS resulting from application

This clause of Part 1 is applicable.

17 RISK assessment

This clause of Part 1 is applicable.

Add the following new Clauses 101 and 102:

101 Measuring circuits

101.1 General

The current sensor shall provide protection against HAZARDS resulting from NORMAL USE and REASONABLY FORESEEABLE MISUSE of measuring circuits, as specified below.

a) If a HAZARD could result, a current measuring circuit shall not interrupt the circuit being measured during range changing, or during the use of current sensors with an internal current transformer (see 101.2).

b) An electrical quantity that is within specification for any TERMINAL shall not cause a HAZARD when it is applied to that TERMINAL or to any other compatible TERMINAL, with the range and function settings set in any possible manner (see 101.3).

c) Any interconnection between the current sensor and other devices or accessories intended to be used with the current sensor shall not cause a HAZARD even if the documentation or markings prohibit the interconnection while the current sensor is used for measurement purposes (see 6.6).

d) A TEMPORARY OVERVOLTAGE or a TRANSIENT OVERVOLTAGE applied on the measuring circuits' TERMINALS in a voltage measurement function shall not cause a HAZARD (see 101.4).

e) Other HAZARDS that could result from REASONABLY FORESEEABLE MISUSE shall be addressed by RISK assessment (see Clauses 16 and 17).

Conformity is checked as specified in 6.6, Clause 16, Clause 17, 101.2, 101.3 and 101.4, as applicable.

101.2 Current sensor with an internal current transformer

If a high voltage could be generated by an open-circuit condition of the output circuit, any voltage above the levels of 6.3.2 shall not be ACCESSIBLE.

Conformity is checked by inspection of the output circuit TERMINALS or connector and, in case of doubt, by measurement of the output circuit voltage when the output circuit is interrupted while the current sensor is operating at the RATED current of the JAWS. The output circuit voltage is measured as specified in 6.3.2.

101.3 Protection against mismatches of inputs and ranges

101.3.1 General

In NORMAL CONDITION and in cases of REASONABLY FORESEEABLE MISUSE, no HAZARD shall arise when the highest RATED voltage or current of a measuring circuit TERMINAL is applied to that TERMINAL or to any other compatible TERMINAL, with any combination of function and range settings.

NOTE Mismatches of inputs and ranges are examples of REASONABLY FORESEEABLE MISUSE, even if the documentation or markings prohibit such mismatch. A typical example is inadvertent connection of a high voltage to a measuring input intended for current or resistance. Possible HAZARDS include electric shock, burns, fire, arcing and explosion.

TERMINALS that are clearly not of similar types and that will not retain the connectors of the probe or accessory do not need to be tested and TERMINALS that can only be accessed by use of a TOOL do not need to meet the requirement of 101.3.1.

The current sensor shall provide protection against these HAZARDS. One of the following techniques shall be used.

a) Use of a certified overcurrent protection device to interrupt short-circuit currents before a HAZARD arises. In this case, the requirements and test of 101.3.2 apply.

b) Use of an uncertified current limitation device, an impedance, or a combination of both to prevent the HAZARD from arising. In this case, the requirements and tests of 101.3.3 apply.

Conformity is checked by inspection, evaluation of the design of the current sensor, and as specified in 101.3.2 and 101.3.3, as applicable.

101.3.2 Protection by a certified overcurrent protection device

An overcurrent protection device is considered suitable if it is certified by an independent laboratory and if all of the following requirements are met.

a) The a.c. and d.c. RATED voltages of the overcurrent protection device shall be at least as high as, respectively, the highest a.c. and d.c. RATED voltages of any measuring circuit TERMINAL on the current sensor.

b) The RATED time-current characteristic (speed) of the overcurrent protection device shall be such that no HAZARD will result from any possible combination of RATED input voltages, TERMINALS, and range selection.

NOTE In practice, downstream circuit elements such as components and printed wiring board traces are selected to be able to withstand the energy that the overcurrent protection device will let through.

c) The a.c. and d.c. RATED breaking capacities of the overcurrent protection device shall exceed, respectively, the possible a.c. and d.c. short-circuit currents.

The possible a.c. and d.c. short-circuit currents shall be calculated as the highest RATED voltages for any TERMINAL divided by the impedance of the overcurrent-protected measuring circuit, taking the impedance of the test leads specified in 101.3.4 into account.

For MEASUREMENT CATEGORIES II and III, the possible a.c. short-circuit current does not need to exceed the applicable values of Table AA.1.

Additionally, spacings surrounding the overcurrent protection device in the current sensor and following the protection device in the measuring circuit shall be sufficiently large to prevent arcing after the protection device opens.

Conformity is checked by inspection of the RATING of the overcurrent protection device and by the following test.

If the protection device is a fuse, it is replaced with an open-circuited fuse. If the protection device is a circuit-breaker, it is set to its open position. A voltage of two times the highest RATED voltage for any TERMINAL is applied to the TERMINALS of the overcurrent-protected measuring circuit for 1 min. During and after the test, no damage to the current sensor shall occur.

101.3.3 Protection by uncertified current limitation devices or by impedances

Devices used for current limitation shall be capable of safely withstanding, dissipating, or interrupting the energy that will result from the application of the maximum RATED voltage of any compatible TERMINAL in NORMAL CONDITION and in the case of REASONABLY FORESEEABLE MISUSE.

An impedance used for limitation of current shall be one or more of the following.

a) An appropriate single component which is constructed, selected, and tested so that safety and reliability for protection against relevant HAZARDS is assured. In particular, the component shall:

1) be RATED for the maximum voltage that may be present in NORMAL CONDITION or during the REASONABLY FORESEEABLE MISUSE event;

2) if a resistor, be RATED for twice the power or energy dissipation that may result in NORMAL CONDITION or from the REASONABLY FORESEEABLE MISUSE event;

3) meet the applicable CLEARANCE and CREEPAGE DISTANCE requirements of Annex K for BASIC INSULATION between its terminations.

b) A combination of components which shall:

1) withstand the maximum voltage that may be present in NORMAL CONDITION or during the REASONABLY FORESEEABLE MISUSE event;

2) be able to dissipate the power or energy that may result in NORMAL CONDITION or from the REASONABLY FORESEEABLE MISUSE event;

3) meet the applicable CLEARANCE and CREEPAGE DISTANCE requirements of Annex K for BASIC INSULATION between the terminations of the combination of components.

NOTE 1 The CLEARANCES and CREEPAGE DISTANCES take into account the WORKING VOLTAGE across each insulation.

Conformity is checked by inspection and the following test, performed three times on the same unit of current sensor. If the test results in heating of any component, the current sensor is allowed to cool before the test is repeated. If a device used for current limitation is damaged, it is replaced before the test is repeated.

The possible a.c. and d.c. short-circuit currents are calculated as the highest RATED voltage for any TERMINAL divided by the impedance of the current-limited measuring circuit, taking the impedance of the test leads specified in 101.3.4 into account. For MEASUREMENT CATEGORIES II and III, the possible a.c. short-circuit current should not exceed the values in Table AA.1.

A voltage equal to the highest RATED voltage for any TERMINAL is applied between the TERMINALS of the measuring circuit for 1 min. The source of the test voltage shall be able to deliver a current of at least the possible a.c. or d.c. short-circuit current as applicable. If the function or range controls have any effect on the electrical characteristics of the input circuit, the test is repeated with the function or range controls in every combination of positions, including during the change of function or range. During the test, the voltage output of the source is measured. If the source voltage decreases by more than 20 % for more than 10 ms, the test is considered inconclusive and is repeated with a lower impedance source.

During and after the test, no HAZARD shall arise, nor shall there be any evidence of fire, arcing, explosion, or damage to current limitation devices, impedances or any component intended to provide protection against electric shock, heat, arc or fire, including the ENCLOSURE and traces on the printed wiring board.

NOTE 2 This test can be extremely hazardous. Explosion shields and other provisions can be used to protect personnel performing the test.

101.3.4 Test leads for the tests of 101.3.2 and 101.3.3

The tests of 101.3.2 and 101.3.3 shall be performed with all test leads that are specified or supplied by the manufacturer for use with the current sensor and if the manufacturer has not specified the test leads, the tests shall be performed with test leads that meet the following specifications:

a) length = 1,0 m;

b) cross section of the conductor = 1,5 mm², stranded copper wire;

NOTE A conductor with a 16 AWG (American Wire Gauge) cross section is acceptable.

c) connector compatible with the measuring circuit TERMINALS;

d) connection to the test voltage source via a bare wire into suitable screw TERMINALS or thimble connectors (twist-on wire connectors) or equivalent means of providing a low-impedance connection;

e) arranged as straight as possible.

Test leads built to these specifications will have a d.c. resistance of about 15 mΩ each, or 30 mΩ per pair. For the purposes of calculation of possible fault current in 101.3.2 and 101.3.3, the value of 30 mΩ can be used for these test leads.

If the manufacturer-supplied test leads are permanently connected to the current sensor, then the attached test leads supplied by the manufacturer shall be used without modification.

101.4 Protection against MAINS overvoltages

To ensure protection against arc flash or fire, measuring circuits RATED for measuring MAINS voltages shall have minimum CLEARANCES and CREEPAGE DISTANCES equivalent to BASIC INSULATION between MAINS-connected conductive parts of opposite polarity.

Conformity is checked by inspection and measurement.

In addition, the measuring circuit TERMINALS of a voltage measuring circuit that are RATED for MEASUREMENT CATEGORIES III or IV shall withstand the applicable TRANSIENT OVERVOLTAGE with the voltage measurement function selectors set for the proper function and range, without damage which could cause a HAZARD.

Conformity is checked by the following impulse voltage test using the applicable impulse voltage of Table 104.

The impulse voltage is applied between each pair of TERMINALS RATED for MEASUREMENT CATEGORY III or IV. The impulse voltage test shall be conducted for five impulses of each polarity spaced up to 1 min apart, from a hybrid impulse generator (see IEC 61180). The generator produces an open-circuit voltage waveform of 1,2/50 μs, a short-circuit current waveform of 8/20 μs, with an output impedance (peak open-circuit voltage divided by peak short-circuit current) of 2 Ω for MEASUREMENT CATEGORIES III and IV. Resistance may be added in series if needed to raise the impedance.

The impulse voltage is applied while the circuit is working under conditions of NORMAL USE, in combination with the MAINS voltage.

The MAINS voltage used for the test is the maximum RATED line-to-neutral voltage of the MAINS being measured. For measuring circuits RATED for MAINS line-to-neutral voltages above 400 V a.c. r.m.s. or d.c., the test may be performed with an available MAINS voltage source that has a line-to-neutral voltage of at least 400 V a.c. r.m.s. or d.c. The MAINS voltage source does not, in this case, need to match the measuring circuit RATING, but circuits RATED for a.c. or a.c. plus d.c. shall be tested with an a.c. source, and circuits RATED for d.c. only shall be tested with a d.c. source.

NOTE 1 The impulses are synchronized with the MAINS voltage phase, timed to occur at the peak of the MAINS voltage, and to be of the same polarity, with a phase tolerance of ±10° (see IEC 61180).

NOTE 2 This test can be extremely hazardous. Explosion shields and other provisions can be used to protect personnel performing the test.

When verifying CLEARANCES within the current sensor by an impulse voltage test, it is necessary to ensure that the specified impulse voltage appears at the CLEARANCE.

The wave shape of each impulse shall be observed (see Note 3). Distortions of the impulse voltage which do not change from impulse to impulse may be caused by operation of an overvoltage limiting device and do not indicate a (partial) breakdown of solid insulation.

No HAZARD shall arise. No flashover of CLEARANCES or breakdown of solid insulation shall occur during the test, but partial discharges are allowed. Partial discharge will be indicated by a step in the resulting wave shape which will occur earlier in successive impulses. Breakdown on the first impulse may either indicate a complete failure of the insulation system or the operation of overvoltage limiting devices in the current sensors. If overvoltage limiting devices are present, they shall not rupture or overheat during the test. Tripping the circuit breaker of the MAINS installation is an indication of failure. If the results of the test are questionable or inconclusive, the test is to be repeated two more times.

NOTE 3 Partial discharges in voids can lead to partial notches of extremely short durations in the wave shape which can be repeated in the course of an impulse.

102 Prevention of HAZARD from arc flash and short-circuits

102.1 General

When a current sensor temporarily bridges two high-energy conductors, it may cause a short-circuit, resulting in high current flow through the current sensor. The current sensor may

become hot, or may melt. This may cause burns to an OPERATOR or a bystander near the current sensor.

If contact is broken (by OPERATOR action, melting, or other event) while current is flowing through the current sensor, arcing may occur. The arcing will ionize the air in the vicinity of the arc, permitting continued current flow in the vicinity of the current sensor. If there is sufficient available energy, then the ionization of the air will continue to spread and the flow of current through the air continues to increase. The result is an arc flash, which is similar to an explosion, and can cause injury or death to an OPERATOR or a bystander.

The current sensor shall be constructed to mitigate the RISK of arc flash and short-circuits.

Conformity is checked as specified in 102.2 and 102.3. All measurements and tests of 102.2 and 102.3 are done after the JAW ENDS abrasion test of 8.101, if applicable.

102.2 Protection against short-circuits during clamping

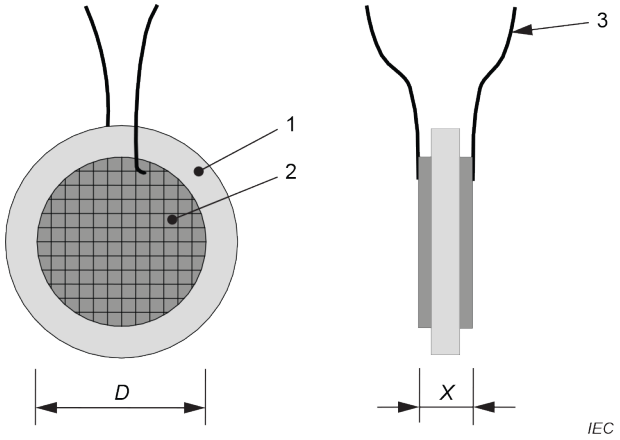
Type A and Type B current sensors shall have additional protection against a short-circuit caused by the JAWS during insertion and removal between conductors and between busbars. This requirement is not applicable to Type A current sensors with fork-style JAWS which do not clamp the conductors or the busbars.

NOTE Examples of protective measures are shrouds, PROTECTIVE BARRIERS, covers, or distances on the opposite sides of the JAW ENDS.

For the purposes of this document, it is assumed that a single JAW END is not able to short-circuit two separated conductors in an electric installation. The maximum voltage between two UNINSULATED CONDUCTORS which could be short-circuited during clamping is considered to be equal to or lower than the line-to-line voltage of the distribution system for which the current sensor is RATED.

Conformity is checked by inspection and, if applicable, by the a.c. test of 6.8.3.1 with a duration of at least 1 min or, for d.c. current sensors, the 1 min d.c. test of 6.8.3.2 using the test voltages from Table 105 applied between the test lead wires for each voltage of Table 105 up to and including the highest RATED voltage of the JAWS, while each specified test probe of Figure 106 and of Table 105 for the considered voltage is inserted into the JAW opening as shown in Figure 107.

EXAMPLE If the RATED voltage of the JAWS is 450 V, then the tests are performed with a 6 mm probe, a 10 mm probe, and a 15 mm probe.



Key

1 Non-conductive base material
2 Conductive surface material
3 Test lead wires
D Diameter of conductive surface material
X Overall thickness of test probe

Figure 106 – Test probe to check protection against short-circuits

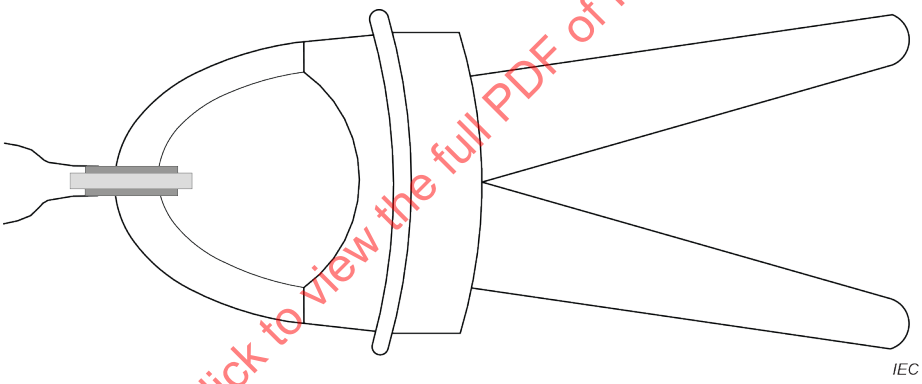


Figure 107 – Use of the test probe of Figure 106

Table 105 – Thickness of the test probe of Figure 106 and test voltages

RATED a.c. r.m.s. or d.c voltage of the JAWS V	Thickness *X* of the test probe [a] mm	Test voltage [b]	
		1 min a.c. test V r.m.s.	1 min d.c. test V d.c.
≤ 150	6	350	500
> 150 ≤ 300	10	650	920
> 300 ≤ 600	15	1 300	1 850
> 600 ≤ 1 000	25	2 200	3 100
> 1 000 ≤ 1 500	25	3 000	4 250
> 1 500 ≤ 2 000	25	3 750	5 300
> 2 000 ≤ 3 000	25	5 250	7 400

[a] If the JAWS do not open to the appropriate dimension, the probe thickness will equal the maximum JAW opening.

[b] The values for the test voltage apply to tests performed at 2 000 m. For other test site altitudes, the corrections of Table 10 are applied.

102.3 Protection against short-circuits in closed position

In closed position, JAWS of Type A, Type B, and Type C current sensors shall have BASIC INSULATION between the outer surface of the ENCLOSURE of the JAWS and all conductive parts including small metal parts such as screws or rivets, except the JAW ENDS. This requirement is also applicable to Type A current sensors with fork-style JAWS, by assimilating the rigid ENCLOSURE of the JAWS without the JAW ENDS being in a closed position.

Conductive parts of the JAW ENDS shall not be ACCESSIBLE in closed position.

Conformity is checked by inspection, by the tests of K.101.4 for solid insulation and by the determination of whether the JAW ENDS are ACCESSIBLE in closed position in accordance with 6.2. For the voltage tests, insulated outer surfaces of the ENCLOSURE of the JAWS are covered with metal foil everywhere except around the JAW ENDS. The distance from the foil to the JAW ENDS is the applicable CLEARANCE.

Annexes

All annexes of Part 1 are applicable except as follows.

Annex D
(normative)

Parts between which insulation requirements are specified (see 6.4 and 6.5.3)

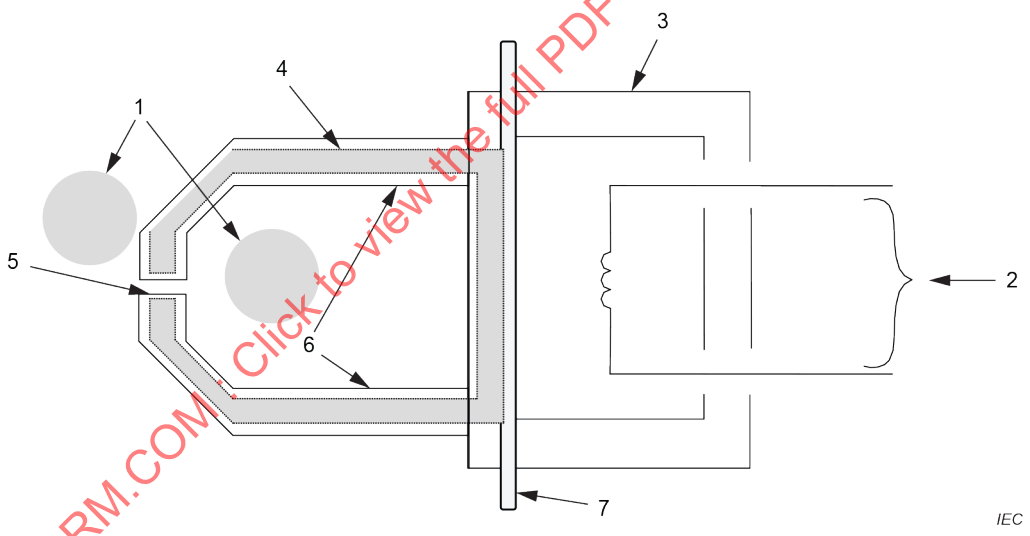
Replace the title of Annex D with the following title:

Annex D
(normative)

Parts between which insulation requirements are specified (see 6.4, 6.5.3, 6.9.101 and 6.101)

Add the following new paragraph, figure and table at the end of Annex D.

Figure D.101 and Table D.101 show parts of current sensors between which insulation is required as specified.



Key

1	HAZARDOUS LIVE UNINSULATED CONDUCTOR within the JAWS or near the JAWS		
2	Input/output circuit	3	HAND-HELD or hand-manipulated parts
4	Magnetic circuit	5	JAW END
6	JAW ENCLOSURE	7	PROTECTIVE BARRIER

Figure D.101 – Parts of current sensors (see also Table D.101)

Table D.101 – Insulation requirements for current sensors

Current sensor	Insulation between parts							
	1 and 2	1 and 3	1 and 4 [a]	2 and 3 [b]	2 and 5	2 and 6 [b]	3 and 5	4 and 6
Type A	D	D	B	D	D	D	D	B
Type B	D	-	B	D	D	D	-	B
Type C	D	-	B	D	-	D	-	B
Type D	NA	NA	NA	D	B	D	-	-

Numbers in the second row refer to those of Figure D.101 parts.

The following symbols are used to indicate:

- \- no requirement
- B BASIC INSULATION is required
- D DOUBLE INSULATION or REINFORCED INSULATION is required
- NA not applicable

[a] Only in closed position.

[b] Parts 3 and 6 are parts of the current sensor ENCLOSURE (see also Figures D.2 c) and D.2 d)).

Annex F
(normative)

Routine tests

F.1 General

Replace the first sentence with the following text:

The manufacturer shall perform the tests of Clauses F.2 to F.4 and Clause F.101 on 100 % of the current sensors produced that have both HAZARDOUS LIVE parts and ACCESSIBLE conductive parts.

Add the following new clause:

F.101 JAWS of current sensors

For Type A, Type B, and Type C current sensors, a test voltage for BASIC INSULATION is applied between:

a) exposed conductive parts of the JAWS or JAW ENDS, and

b) ACCESSIBLE conductive parts within the HAND-HELD or hand-manipulated area and input and output circuits connected together.

Type D current sensors and other current sensors whose JAWS and JAW ENDS do not have ACCESSIBLE conductive parts do not need to be subjected to this test.

The test voltage may be a.c. using the applicable test voltage of Table K.102, d.c. or impulse using the applicable test voltage of Table K.103, for the appropriate MEASUREMENT CATEGORY. The d.c. test voltage value is equal to 1,414 the a.c. test voltage value. For the a.c. and d.c. tests, the test voltage is raised to its specified value within 5 s, and maintained for at least 2 s. Impulse tests are the 1,2/50 µs test specified in IEC 61180 conducted for a minimum of three pulses of each polarity at 1 s minimum intervals. For current sensors not RATED for MEASUREMENT CATEGORY, the value of the test voltage is 1,5 times the RATED voltage to earth of the JAWS but not less than 350 V a.c. r.m.s. or 500 V d.c.

No flashover of CLEARANCES or breakdown of solid insulation shall occur during the test.

Annex K
(normative)

Insulation requirements not covered by 6.7

K.3 Insulation in circuits not addressed in 6.7, Clause K.1 or Clause K.2

Replace the existing title of Clause K.3 with the following:

K.3 Insulation for circuits not addressed in 6.7, Clauses K.1, K.2 or K.101 and for measuring circuits where MEASUREMENT CATEGORIES do not apply

K.3.1 General

Replace the text with the following:

These circuits have one or more of the following characteristics:

a) the maximum possible TRANSIENT OVERVOLTAGE is limited by the supply source or within the current sensor (see Clause K.4.) to a known level below the level assumed for the MAINS CIRCUIT;

b) the maximum possible TRANSIENT OVERVOLTAGE is above the level assumed for the MAINS CIRCUIT;

c) the WORKING VOLTAGE is the sum of voltages from more than one circuit, or is a mixed voltage;

d) the WORKING VOLTAGE includes a recurring peak voltage that may include a periodic non-sinusoidal waveform or a non-periodic waveform that occurs with some regularity;

e) the WORKING VOLTAGE has a frequency above 30 kHz;

f) the circuit is a measuring circuit where MEASUREMENT CATEGORIES do not apply.

In cases a) to c) and f), CLEARANCES for BASIC INSULATION and SUPPLEMENTARY INSULATION are determined according to K.3.2.

In cases d) and e) CLEARANCES are determined according to K.3.3.

In all cases, K.3.4 addresses CREEPAGE DISTANCE and K.3.5 solid insulation.

NOTE These requirements are illustrated in the flowchart of Annex DD, Figure DD.1.

Add the following new clause and tables:

K.101 Insulation requirements for measuring circuits RATED for MEASUREMENT categories

K.101.1 General

Measuring circuits are subjected to WORKING VOLTAGES and transient stresses from the circuits to which they are connected during measurement or test. When the measuring circuit is used to measure MAINS, the transient stresses can be estimated by the location within the installation at which the measurement is performed. When the measuring circuit is used to measure any other electrical signal, the transient stresses shall be considered by the OPERATOR to ensure that they do not exceed the capabilities of the measuring current sensor.

When the measuring circuit is used to connect to MAINS, there is a RISK of arc blast. MEASUREMENT CATEGORIES define the amount of energy available, which may contribute to arc flash. In conditions where arc flash may occur, additional precautions identified by the manufacturer to reduce the HAZARD related to shock and burn from arc flash should be described in the user documentation (see also Annexes AA and BB).

K.101.2 CLEARANCES

For a current sensor intended to be powered from the circuit being measured, CLEARANCES for the MAINS CIRCUIT shall be designed according to the requirements of the RATED MEASUREMENT CATEGORY. Additional marking requirements are specified in 5.1.5.2, 5.1.5.101 and 5.1.5.102.

CLEARANCES of measuring circuits RATED for MEASUREMENT CATEGORIES are specified in Table K.101.

NOTE 1 See Annex I for nominal voltages of MAINS supplies.

If the current sensor is RATED to operate at an altitude greater than 2 000 m, the values for CLEARANCES shall be multiplied by the applicable factor of Table K.1.

Minimum CLEARANCE for BASIC INSULATION, SUPPLEMENTARY INSULATION and REINFORCED INSULATION is 0,2 mm for POLLUTION DEGREE 2 and 0,8 mm for POLLUTION DEGREE 3.

NOTE 2 CLEARANCES for other measuring circuits are calculated according to Clause K.3.

Table K.101 – CLEARANCES of measuring circuits RATED for MEASUREMENT CATEGORIES

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured	CLEARANCE mm					
	BASIC INSULATION and SUPPLEMENTARY INSULATION			REINFORCED INSULATION		
V	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV
≤ 50	0,04	0,1	0,5	0,1	0,32	1,4
> 50 ≤ 100	0,1	0,5	1,5	0,32	1,4	3,0
> 100 ≤ 150	0,5	1,5	3,0	1,4	3,0	6,0
> 150 ≤ 300	1,5	3,0	5,5	3,0	6	10,4
> 300 ≤ 600	3,0	5,5	8	6	10,4	15
> 600 ≤ 1 000	5,5	8	14	10,4	15	23,9
> 1 000 ≤ 1 500	8	11	18	16	22	36
> 1 500 ≤ 2 000	14	18	22	28	36	44
> 2 000 ≤ 3 000	18	22	25	36	44	50

Conformity is checked by inspection and measurement or by the a.c. voltage test of 6.8.3.1 with a duration of at least 5 s, or the impulse voltage test of 6.8.3.3, or, for measuring circuits stressed only by d.c., the d.c. voltage test of 6.8.3.2 with a duration of at least 5 s, using the applicable test voltage of Table K.16 for the required CLEARANCE. The value of the d.c. test voltage is √2 times the a.c. r.m.s. test voltage.

K.101.3 CREEPAGE DISTANCES

The requirements of K.2.3 apply.

Conformity is checked as specified in K.2.3.

K.101.4 Solid insulation

K.101.4.1 General

K.101.4.1.1 Solid insulation shall withstand the electrical and mechanical stresses that may occur in NORMAL USE, in all RATED environmental conditions (see 1.4), during the intended life of the current sensor.

The manufacturer should take the expected life of the current sensor into account when selecting insulating materials.

Conformity is checked by both of the following tests:

a) the a.c. voltage test of 6.8.3.1 with a duration of at least 5 s using the applicable test voltage of Table K.102 or the impulse voltage test of 6.8.3.3 using the applicable test voltage of Table K.103, including for measuring circuits stressed only by d.c.;

b) the a.c. voltage test of 6.8.3.1 with a duration of at least 1 min or, for measuring circuits stressed only by d.c., the d.c. voltage test of 6.8.3.2 with a duration of at least 1 min using the test voltage determined by K.101.4.1.2.

NOTE Test a) checks the effects of TRANSIENT OVERVOLTAGES, while test b) checks the effects of long-term stress of solid insulation.

Table K.102 – a.c. test voltages for testing electric strength of solid insulation in measuring circuits RATED for MEASUREMENT CATEGORIES

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	a.c. test voltage V r.m.s.					
	BASIC INSULATION and SUPPLEMENTARY INSULATION			REINFORCED INSULATION		
	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV
≤ 50	370	500	840	500	720	1 300
> 50 ≤ 100	500	840	1 400	720	1 300	2 200
> 100 ≤ 150	840	1 400	2 200	1 300	2 200	3 500
> 150 ≤ 300	1 400	2 200	3 300	2 200	3 500	5 100
> 300 ≤ 600	2 200	3 300	4 300	3 500	5 100	7 000
> 600 ≤ 1 000	3 300	4 300	6 600	5 100	7 000	10 000
> 1 000 ≤ 1 500	4 300	5 400	8 200	7 400	9 700	15 000
> 1 500 ≤ 2 000	6 600	8 200	9 700	12 000	15 000	18 000
> 2 000 ≤ 3 000	8 200	9 700	11 000	15 000	18 000	20 000

Table K.103 – Impulse test voltages for testing electric strength of solid insulation in measuring circuits RATED for MEASUREMENT CATEGORIES

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	Impulse test voltage V peak					
	BASIC INSULATION and SUPPLEMENTARY INSULATION			REINFORCED INSULATION		
	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV
≤ 50	500	800	1 500	800	1 280	2 400
> 50 ≤ 100	800	1 500	2 500	1 280	2 400	4 000
> 100 ≤ 150	1 500	2 500	4 000	2 400	4 000	6 400
> 150 ≤ 300	2 500	4 000	6 000	4 000	6 400	9 600
> 300 ≤ 600	4 000	6 000	8 000	6 400	9 600	12 800
> 600 ≤ 1 000	6 000	8 000	12 000	9 600	12 800	19 200
> 1 000 ≤ 1 500	8 000	10 000	15 000	13 500	17 900	27 100
> 1 500 ≤ 2 000	12 000	15 000	18 000	21 400	27 100	32 000
> 2 000 ≤ 3 000	15 000	18 000	20 000	27 100	32 000	36 000

K.101.4.1.2 Test voltage values for testing the long-term stress of solid insulation are determined as follows:

The test voltage for BASIC INSULATION and SUPPLEMENTARY INSULATION is calculated with the following formula:

$$U_T = A \times U_N + B$$

where U_T is the test voltage, U_N is the nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured and A and B are parameters determined as follows:

when $U_N \leq 1\,000$ V, $A = 1$ and $B = 1\,200$ V

when $U_N > 1\,000$ V, $A = 1{,}5$ and $B = 750$ V

The a.c. test voltage is equal to U_T and the d.c. test voltage is equal to $1{,}414 \times U_T$.

For REINFORCED INSULATION, the test voltage value is twice the value for BASIC INSULATION.

The rounded values of Table K.104 can also be used:

Table K.104 –Test voltages for testing long-term stress of solid insulation in measuring circuits RATED for MEASUREMENT CATEGORIES

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	Test voltage			
	1-min a.c. test V r.m.s.		1-min d.c. test V d.c.	
	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION
≤ 50	1 250	2 500	1 750	3 500
> 50 ≤ 100	1 300	2 600	1 850	3 700
> 100 ≤ 150	1 350	2 700	1 900	3 800
> 150 ≤ 300	1 500	3 000	2 100	4 200
> 300 ≤ 600	1 800	3 600	2 550	5 100
> 600 ≤ 1 000	2 200	4 400	3 100	6 200
> 1 000 ≤ 1 500	3 000	6 000	4 250	8 500
> 1 500 ≤ 2 000	3 750	7 500	5 300	10 600
> 2 000 ≤ 3 000	5 250	10 500	7 400	14 800

K.101.4.1.3 Solid insulation shall also meet the following requirements, as applicable:

1) for solid insulation used as an ENCLOSURE or PROTECTIVE BARRIER, the requirements of Clause 8;
2) for moulded and potted parts, the requirements of K.101.4.2;
3) for insulating layers of printed wiring boards, the requirements of K.101.4.3;
4) for thin-film insulation, the requirements of K.101.4.4.

Conformity is checked as specified in K.101.4.2 to K.101.4.4, and Clause 8, as applicable.

K.101.4.2 Moulded and potted parts

For BASIC INSULATION, SUPPLEMENTARY INSULATION, and REINFORCED INSULATION, conductors located between the same two layers moulded together (see Figure K.1, item L) shall be separated by at least the applicable minimum distance of Table K.105 after the moulding is completed.

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

K.101.4.3 Insulating layers of printed wiring boards

For BASIC INSULATION, SUPPLEMENTARY INSULATION and REINFORCED INSULATION, conductors located between the same two layers (see Figure K.2, item L) shall be separated by at least the applicable minimum distance of Table K.105.

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

Table K.105 – Minimum values for distance or thickness of solid insulation in measuring circuits RATED FOR MEASUREMENT CATEGORIES

Line-to-neutral voltage V r.m.s. or d.c.	Minimum thickness [a] mm	Minimum distance L (see Figure K.2) [a, b] mm
≤ 300	0,4	0,4
> 300 ≤ 600	0,6	0,6
> 600	1,0	1,0

[a] These values are independent of the MEASUREMENT CATEGORY.

[b] These values apply for BASIC INSULATION, SUPPLEMENTARY INSULATION and REINFORCED INSULATION.

REINFORCED INSULATION of inner insulating layers of printed wiring boards shall also have adequate electric strength through the respective layers. One of the following methods shall be used.

a) The thickness through the insulation is at least the applicable value of Table K.105.

   Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

b) The insulation is assembled from at least two separate layers of printed wiring board materials, each of which is RATED by the manufacturer of the material for an electric strength of at least the value of the applicable test voltage of Table K.102 or Table K.103 for BASIC INSULATION.

   Conformity is checked by inspection of the manufacturer's specifications.

c) The insulation is assembled from at least two separate layers of printed wiring board materials, and the combination of layers is RATED by the manufacturer of the material for an electric strength of at least the value of the applicable test voltage of Table K.102 or of Table K.103 for REINFORCED INSULATION.

   Conformity is checked by inspection of the manufacturer's specifications.

K.101.4.4 Thin-film insulation

For BASIC INSULATION, SUPPLEMENTARY INSULATION and REINFORCED INSULATION, conductors located between the same two layers (see Figure K.3, item L) shall be separated by at least the applicable CLEARANCE and CREEPAGE DISTANCE of K.101.2 and K.101.3.

Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

REINFORCED INSULATION through the layers of thin-film insulation shall also have adequate electric strength. One of the following methods shall be used.

a) The thickness through the insulation is at least the applicable value of Table K.105.

   Conformity is checked by inspection and either by measurement of the separation or by inspection of the manufacturer's specifications.

b) The insulation consists of at least two separate layers of thin-film materials, each of which is RATED by the manufacturer of the material for an electric strength of at least the value of the applicable test voltage of Table K.102 or Table K.103 for BASIC INSULATION.

   Conformity is checked by inspection of the manufacturer's specifications.

c) The insulation consists of at least three separate layers of thin-film materials, any two of which have been tested to exhibit adequate electric strength.

   Conformity is checked by the voltage tests of K.101.4.1.1 applied to two of the three layers for REINFORCED INSULATION.

For the purposes of these tests, a special sample may be assembled with only two layers of the material.

Annex L
(informative)

Index of defined terms

Add the following defined terms:

Add the following new annexes:

Annex AA
(normative)

MEASUREMENT CATEGORIES

AA.1 General

For the purposes of this document, the following MEASUREMENT CATEGORIES are used. These MEASUREMENT CATEGORIES are not the same as the OVERVOLTAGE CATEGORIES in accordance with Annex K of Part 1 and with IEC 60664-1, or the classification of rated impulse voltages (overvoltage categories) in accordance with IEC 60364-4-44.

MEASUREMENT CATEGORIES are based on locations on the MAINS where measurements may be made.

NOTE IEC 60664-1 and IEC 60364-4-44 categories are created to achieve an insulation coordination of the components and equipment used within MAINS.

AA.2 MEASUREMENT CATEGORIES

AA.2.1 MEASUREMENT CATEGORY II

MEASUREMENT CATEGORY II is applicable to test and measuring circuits connected directly to utilization points (socket outlets and similar points) of the low-voltage MAINS installation (see Table AA.1 and Figure AA.1).

EXAMPLE Measurements on MAINS CIRCUITS of household appliances, portable TOOLS and similar equipment, and on the consumer side only of socket-outlets in the fixed installation.

AA.2.2 MEASUREMENT CATEGORY III

MEASUREMENT CATEGORY III is applicable to test and measuring circuits connected to the distribution part of the building's low-voltage MAINS installation (see Table AA.1 and Figure AA.1).

To avoid RISKS caused by the HAZARDS arising from these higher short-circuit currents, additional insulation and other provisions are required.

For equipment that is part of a fixed installation, the fuse or circuit breaker of the installation is considered to provide adequate protection against short-circuit currents.

EXAMPLE Measurements on distribution boards (including secondary meters), photovoltaic panels, circuit-breakers, wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and equipment for industrial use and some other equipment such as stationary motors with permanent connection to the fixed installation.

AA.2.3 MEASUREMENT CATEGORY IV

MEASUREMENT CATEGORY IV is applicable to test and measuring circuits connected at the source of the building's low-voltage MAINS installation (see Table AA.1 and Figure AA.1).

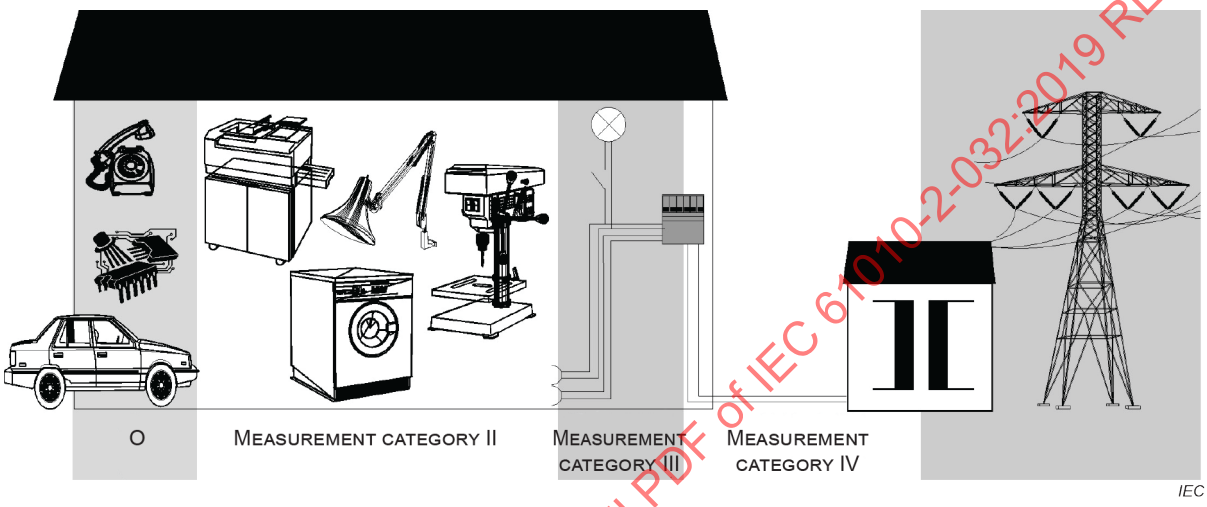
Owing to the high potential short-circuit currents existing in these circuits, any accidental short-circuit caused whilst making measurements can create a high-energy-level arc flash which is extremely dangerous to bystanders in the immediate vicinity. Great precautions shall be taken to avoid any chance of a short-circuit.

EXAMPLE Measurements on devices installed before the main fuse or circuit breaker in the building installation.

AA.2.4 Measuring circuits without a MEASUREMENT CATEGORY RATING

Many types of test and measuring circuits are not intended to be directly connected to the MAINS supply. Some of these measuring circuits are intended for very low energy applications, but others of these measuring circuits may experience very high amounts of available energy because of high short-circuit currents or high open-circuit voltages. There are no standard transient levels defined for these circuits. An analysis of the WORKING VOLTAGES, loop impedances, TEMPORARY OVERVOLTAGES, and TRANSIENT OVERVOLTAGES in these circuits is necessary to determine the insulation requirements and short-circuit current requirements.

EXAMPLE Thermocouple measuring circuits, high-frequency measuring circuits, automotive testers, and testers used to characterize the MAINS installation before the installation is connected to the MAINS supply.



Key

O	Measuring circuits without a MEASUREMENT CATEGORY
CAT II	MEASUREMENT CATEGORY II
CAT III	MEASUREMENT CATEGORY III
CAT IV	MEASUREMENT CATEGORY IV

Figure AA.1 – Example to identify the locations of measuring circuits

Table AA.1 – Characteristics of MEASUREMENT CATEGORIES

MEASUREMENT CATEGORY	Short-circuit current[a] (typical) kA	Location in the building installation
II	< 10	Circuits connected to MAINS socket outlets and similar points in the MAINS installation
III	< 50	MAINS distribution parts of the building
IV	> 50	Source of the MAINS installation in the building

[a] The values of loop impedances (installation impedances) do not take into account the resistance of the test leads and impedances internal to the measuring equipment. These short-circuit currents vary, depending on the characteristics of the installation.

Annex BB
(informative)

HAZARDS pertaining to measurements performed in certain environments

BB.1 General

Annex BB provides guidance to the equipment manufacturer on HAZARDS that should be considered for equipment intended to measure electrical quantities in certain environments. This list of HAZARDS is not to be considered comprehensive: other HAZARDS certainly exist in these and other environments.

BB.2 HAZARDS

BB.2.1 General

Testing and measuring circuits are subjected to WORKING VOLTAGES and transient stresses from the circuit to which they are connected during measurement or test. When the measuring circuit is used to measure MAINS, the transient stresses can be estimated by the location within the installation at which the measurement is performed.

BB.2.2 Electric shock

MAINS circuits present a HAZARD of electric shock. The voltages and currents are above the permissible levels (see 6.3), and access to the circuit is usually required to perform the measurement. The manufacturer should provide adequate information to permit the OPERATOR to be aware of the HAZARD of electric shock, and should ensure that the design requirements of this document and those of other related documents (for example, IEC 61010-031 for voltage probe assemblies) are met.

BB.2.3 Arc blast

Arc flash occurs when a conductor (such as a probe tip or a low-impedance measuring circuit) temporarily bridges two high-energy conductors and then opens or is withdrawn. This can result in arcing, which ionizes the air. Ionized air is conductive and can result in continued current flow in the vicinity of the conductors.

The arc flash will release significant amounts of very hot air and molten or vaporised metal particles (from the active conductors) which are the primary RISK to the OPERATOR and other persons in the immediate vicinity.

If there is sufficient available energy, then the ionization of the air will continue to spread and the flow of current through the air continues to increase. The result is similar to an explosion, and can cause significant injury or death to an OPERATOR or a bystander. See the descriptions of the MEASUREMENT CATEGORIES in Annex AA for the voltage and energy levels likely to cause arc flash.

BB.2.4 Thermal burns

Any conductor (such as jewellery) that connects two high-energy conductors may become hot from current flow through the item. This can cause burns to the skin adjacent to the item.

BB.3 MAINS

When the measuring circuit is used to measure live MAINS, there is a RISK of arc blast. MEASUREMENT CATEGORIES (see Annex AA) define the amount of energy available, which may contribute to arc flash. In conditions where arc flash can exist, the instructions for use need to specify additional precautions to reduce the HAZARD related to shock and burn from arc flash.

BB.4 Telecommunications networks

The voltages and currents continually present in telecommunications networks are below the levels that could be considered HAZARDOUS LIVE. However, the "ring" voltages (the voltage imposed on the telecommunications line to indicate that the telephone receiver should signal an incoming call) are typically around 90 V a.c., which is considered HAZARDOUS LIVE. If a technician were to come into contact with the hazardous conductor while the ring event occurred, then the technician could suffer an electric shock.

EN 41003 addresses safety requirements for equipment to be connected to telecommunications networks. It addresses the possibility of electric shock from contact with telecommunications conductors, and concludes that, with the access limitations imposed by the connectors, the RISK is reduced to a negligible level. However, if in the process of test or measurement, the conductor is made fully ACCESSIBLE, then there is a possibility of electric shock.

The manufacturer of equipment that may be used for testing and measuring of telecommunications networks should be aware of the HAZARD from the ring voltage and should take suitable steps to reduce the HAZARD (where possible by limiting access to the conductors; in other cases, by providing adequate instructions and warnings to the OPERATOR). Also see IEC 61010-031, which specifies barriers for voltage probes that may be used on HAZARDOUS LIVE voltages.

BB.5 Current measurements in inductive circuits

When a current-measuring device is inserted in series with an inductive circuit, a HAZARD may occur if the circuit is suddenly opened (a probe falls off or a fuse opens, for example). Such sudden events can produce an inductive voltage spike across the unintentional opening of the circuit. These spikes can be many times the magnitude of the WORKING VOLTAGE of the circuit, and can cause breakdown of insulation or electric shock to an OPERATOR.

The manufacturer should provide adequate instructions to an OPERATOR to ensure that current-measuring devices are not used in series with inductive circuits, or if it is necessary to do so, then precautions are taken to mitigate the HAZARD of electric shock from the voltage spike.

BB.6 Battery-driven circuits

Batteries can present electrical, explosion and fire HAZARDS to the person conducting tests on them or their associated circuits. Examples include batteries used for stand-by sources or to operate motors.

HAZARDS may arise from electric shock, explosions from short-circuiting the TERMINALS of the battery, or explosions from arc ignition of gases evolved from the battery during charging cycles.

BB.7 Measurements at higher frequencies

Some measuring equipment depends on inductive connection to the circuit being measured. The behaviour of the measuring circuit will, in these cases, depend on the frequency of the signal being measured. If the measuring device is used to measure a frequency higher than it was designed for, then circulating currents could cause significant heating of some of the conductive parts of the measuring device.

The manufacturer should provide adequate instructions for the use of such devices.

Annex CC
(informative)

4-mm "banana" TERMINALS

CC.1 General

A HAZARD may arise from an OPERATOR's reliance on values displayed by the current sensor when connectors and TERMINALS appear to be in mated position but conductive parts are not in contact.

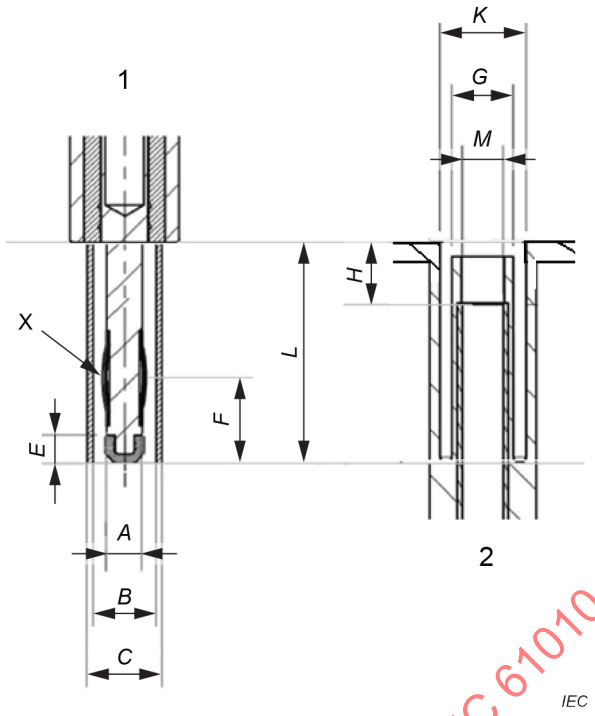
Annex CC gives the recommended dimensions for safety purposes of 4-mm TERMINALS when probe assemblies complying with IEC 61010-031:2015/AMD1:2018, Annex E, can be connected. These 4-mm TERMINALS are often called "banana connectors".

CC.2 Dimensions

The dimensions of Figure CC.1 are compatible with the requirements of TERMINALS RATED for MEASUREMENT CATEGORIES up to 1 000 V.

These dimensions ensure that the CLEARANCES of 6.6.101 are met when the connectors and TERMINALS are mated, unmated or partially mated, and that conductive parts of mated connectors and TERMINALS are in contact.

NOTE Extraction or insertion forces and contact resistance values have not been considered.



Key:

A = 3,90 mm ± 0,05 mm (compressed)	*M* = 4,00 mm + 0,05 mm
B ≥ 6,6 mm	*G* ≤ 6,4 mm
C ≤ 7,9 mm	*K* ≥ 8,1 mm
2,6 mm ≤ *E* ≤ 6 mm	4 mm ≤ *H* ≤ 6 mm
F ≤ 12 mm	*L* ≥ 20 mm

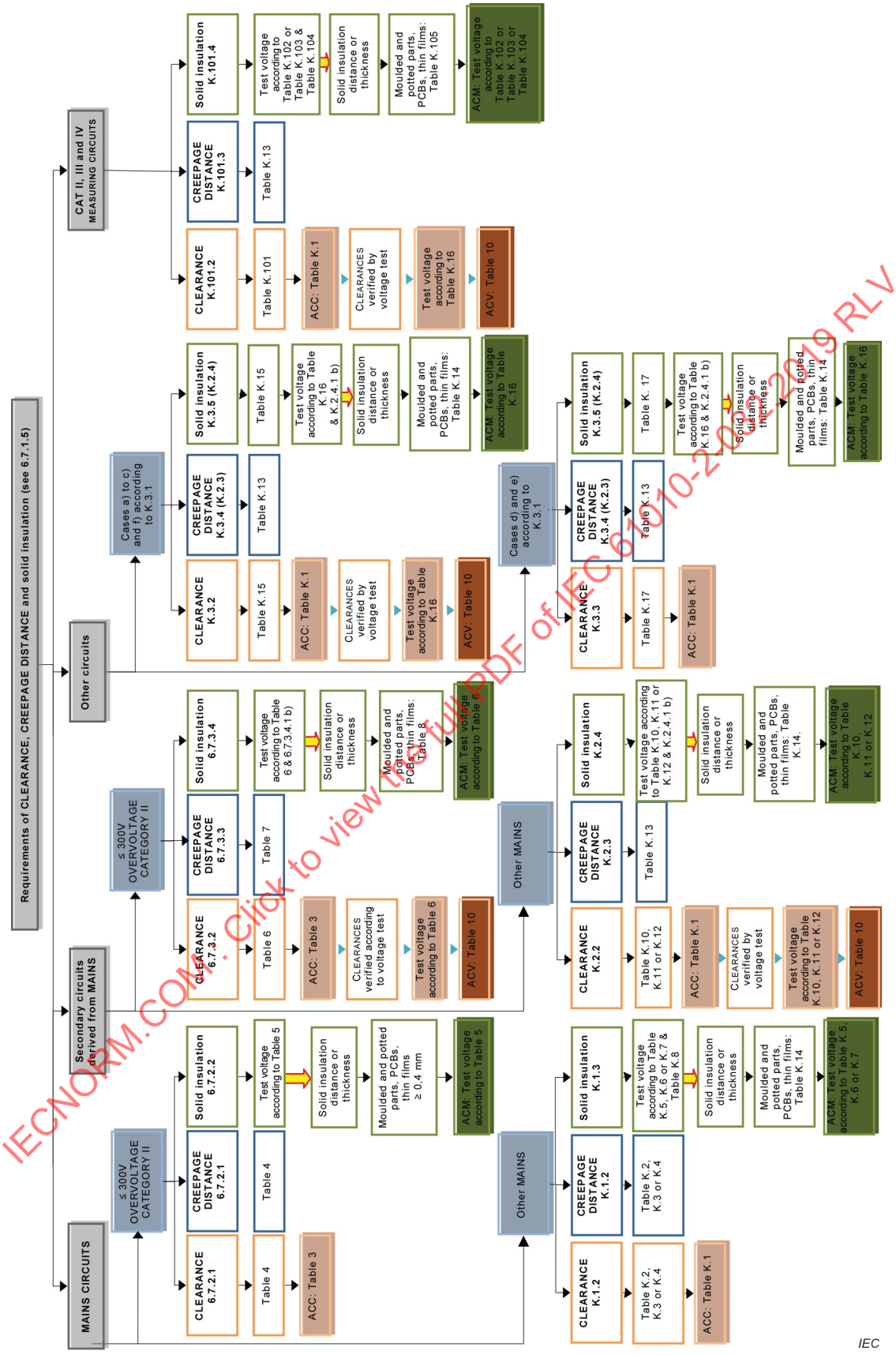
– 1 is a male TERMINAL
– 2 is a female TERMINAL
– X is the point where the best contact occurs
– The minimum value of *E* and *H* depends on whether or not plastic parts are present. CLEARANCES shall be at least 2,6 mm.

Figure CC.1 – Recommended dimensions of 4-mm TERMINALS

Annex DD
(informative)

Flowchart for insulation according to the type of circuit

A circuit can fall under more than one category. It is then necessary to follow two or more branches of the flowchart of Figure DD.1 and compare the results. For example, a measuring circuit can be RATED for MEASUREMENT CATEGORY III and can also be RATED for measuring signals at 1 MHz. This measuring circuit has to be evaluated under both K.3.3 and Clause K.101.



Key

ACC	RATED altitude correction of CLEARANCE
ACV	Site altitude correction of test voltage
&	Both required
ACM	Alternative conformity means
	As applicable
	Optional test path

Figure DD.1 – Requirements for CLEARANCE, CREEPAGE DISTANCE and solid insulation

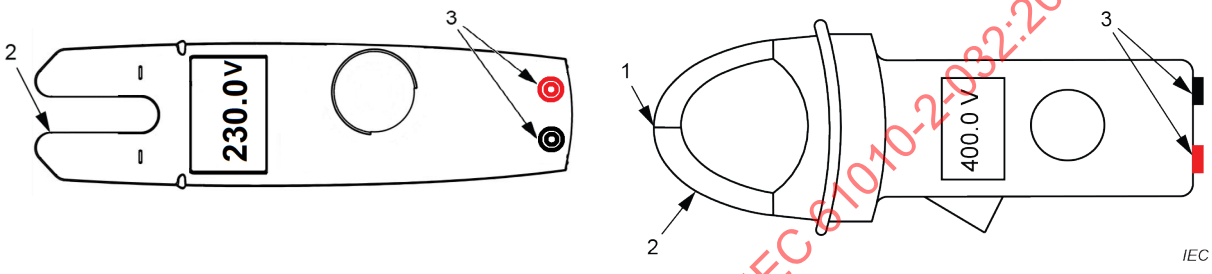
Annex EE
(normative)

CLAMP MULTIMETER

EE.1 General

The primary purpose of CLAMP MULTIMETERS is to measure current and voltage on a live MAINS. The circuit of a CLAMP MULTIMETER to measure current is a Type A or a Type B current sensor.

The following Figure EE.1 shows graphical representations of typical CLAMP MULTIMETERS for illustration purposes. CLAMP MULTIMETERS may look different depending on the design.



CLAMP MULTIMETER with fork-style JAWS Type A current sensor

CLAMP MULTIMETER with clamping Type A current sensor

Key

1 JAW END(S)

2 JAW

3 Input measuring circuit TERMINALS

Figure EE.1 – Examples of CLAMP MULTIMETERS

HAND-HELD clamp meters such as wattmeters, clamps for process control or clamps falling within the scope of IEC 61557-1 to IEC 61557-12 are not considered as CLAMP MULTIMETERS.

Clauses EE.2 to EE.5 give additional requirements for CLAMP MULTIMETERS.

EE.2 CLAMP MULTIMETER RATING

TERMINALS of measuring circuits intended for MAINS voltage measurements and JAWS shall be RATED for a minimum of 300 V a.c. r.m.s. to earth, and a minimum MEASUREMENT CATEGORY III.

The RATED voltage of the TERMINALS of a measuring circuit intended for MAINS voltage measurements shall be equal to or higher than their RATED voltage to earth.

NOTE These TERMINALS can also have RATINGS for other functions.

Conformity is checked by inspection.

EE.3 Marking of measuring circuit TERMINALS and JAWS

TERMINALS of measuring circuits RATED for MAINS voltage measurements and JAWS shall be marked "CAT III" and/or "CAT IV" as applicable. Only marking with both of these MEASUREMENT CATEGORIES associated with their RATED voltage to earth is permissible.

Conformity is checked by inspection.

EE.4 Probe assemblies and accessories

At minimum, one set of the test leads supplied with the CLAMP MULTIMETER shall be RATED according to IEC 61010-031 for at least the highest voltage and MEASUREMENT CATEGORY of the CLAMP MULTIMETER.

Conformity is checked by inspection.

EE.5 Indicating devices

EE.5.1 General

No HAZARD shall occur from reading a voltage value when the CLAMP MULTIMETER is operated for measuring voltages as RATED and in case of REASONABLE FORESEEABLE MISUSE.

A displayed voltage value is considered to be unambiguous when the value is less than 10 % inaccurate, or if there is an indication that the value is out of range when it should be, or if there is a clear indication that the value is not correct. A display off is also considered to be unambiguous.

The tests of EE.5.2, EE.5.3 and EE.5.4 shall be performed when relevant.

The a.c. r.m.s. voltages applied to the TERMINALS during the tests have a frequency of 50 Hz or 60 Hz. The CLAMP MULTIMETER is not required to maintain its normal accuracy during and after the tests.

EE.5.2 Battery level

A voltage value displayed by the CLAMP MULTIMETER shall not be affected by the expected variation of its battery voltage.

Conformity is checked by the following test.

For each measuring circuit TERMINALS RATED for MAINS voltage measurements, the voltage below is applied to these TERMINALS:

– *a.c. measurement TERMINALS are connected to 60 V a.c. r.m.s.*

– *d.c. measurement TERMINALS are connected to 120 V d.c.*

The supply voltage of the d.c. source connected to the battery connectors decreases by no more than 20 mV/s from the maximum battery voltage to zero. The d.c. source used for this test shall be the batteries or similar source while the impedance of the batteries and ripple free conditions are taken into account. The test terminates when the display turns off.

The displayed voltage values during the test shall be unambiguous.

NOTE See EE.5.1 for the meaning of the term "unambiguous".

EE.5.3 Over-range voltages

The CLAMP MULTIMETER shall be able to display unambiguously over-range voltage values whenever the value is above the maximum absolute value of the range to which the CLAMP MULTIMETER is set.

NOTE Examples of ambiguous indications include the following, unless there is a separate unambiguous indication of an over-range value:

a) analogue CLAMP MULTIMETER which stops at the exact ends of the range;

b) digital CLAMP MULTIMETER which shows a low value when the true value is above the range maximum (for example 1 001,5 V displayed as 001,5 V).

Conformity is checked by the following test.

An over-range voltage is applied to the measuring circuit TERMINALS RATED for MAINS voltage measurements of the CLAMP MULTIMETER set to each voltage measurement range.

The value of the over-range voltage applied to the TERMINALS is equal to 110 % of the RATED voltage measurement range. For measurement RATED for d.c., the over-range voltage is applied with positive and negative polarities.

The displayed voltage values during the test shall be unambiguous.

EE.5.4 Permanent overvoltages

The CLAMP MULTIMETER shall be able to withstand permanent overvoltages and continue to give an unambiguous indication of any HAZARDOUS LIVE voltages up to the maximum RATED voltage.

NOTE 1 Subclause 101.4 provides protection against HAZARDS from TRANSIENT OVERVOLTAGES.

Conformity is checked by the following test:

An overvoltage is applied for 5 min to the measuring circuit TERMINALS RATED for MAINS voltage measurements of the CLAMP MULTIMETER set to each voltage measurement range.

The value of the overvoltage applied to the TERMINALS is based on the TERMINALS' RATED voltage:

a) when the TERMINALS' RATED voltage value is up to 1 000 V a.c. r.m.s., the overvoltage value is the TERMINALS' RATED voltage value multiplied by 1,9 but without exceeding 1 100 V a.c. r.m.s.;

b) when the TERMINALS' RATED voltage value is above 1 000 V a.c. r.m.s. the overvoltage value is the RATED voltage value multiplied by 1,1;

c) when the TERMINALS' RATED voltage is d.c., the overvoltage value is the RATED voltage value multiplied by 1,1.

NOTE 2 The 1,9 multiplication factor is derived from phase-to-phase voltage measurements with a 10 % overvoltage condition.

After each overvoltage has been applied, each measuring circuit TERMINAL RATED for MAINS voltage measurements shall in turn:

1) measure a voltage of 60 V a.c. r.m.s. or 120 V d.c. based on the measurement TERMINAL input type;

2) measure a voltage equal to the maximum RATED voltage for the measurement TERMINAL under test.

The above test may need to be repeated at any combination of settings, TERMINALS and voltage RATING. The displayed voltage values shall be unambiguous.

Bibliography

The Bibliography of Part 1 is applicable, except as follows:

Add the following references:

IEC 61010-2-033, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-033: Particular requirements for hand-held multimeters for domestic and professional use capable of measuring mains voltage*

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, *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*

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 61557-3, *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 3: Loop impedance*

IEC 61557-4, *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 61557-5, *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 5: Resistance to earth*

IEC 61557-6, *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 6: Effectiveness of residual current devices (RCD) in TT, TN and IT systems*

IEC 61557-7, *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 7: Phase sequence*

IEC 61557-8, *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 8: Insulation monitoring devices for IT systems*

IEC 61557-9, *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 9: Equipment for insulation fault location in IT systems*

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 and monitoring of protective measures*

IEC 61557-11, *Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 11: Effectiveness of residual current monitors (RCMs) type A and type B in TT, TN and IT systems*

IEC 61557-12, *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 12: Power metering and monitoring devices (PMD)*

IEC TS 62993:2017, *Guidance for determination of clearances, creepage distances and requirements for solid insulation for equipment with a rated voltage above 1 000 V AC and 1 500 V DC, and up to 2 000 V AC and 3 000 V DC*

EN 41003:1999, *Particular safety requirements for equipment to be connected to telecommunications networks and/or a cable distribution system*

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SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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EXIGENCES DE SÉCURITÉ POUR APPAREILS ÉLECTRIQUES DE MESURAGE, DE RÉGULATION ET DE LABORATOIRE –

Partie 2-032: Exigences particulières pour les capteurs de courant, PORTATIFS et manipulés manuellement, pour essai électrique et mesurage

AVANT-PROPOS

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8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

La Norme internationale IEC 61010-2-032 a été établie par le comité d'études 66 de l'IEC: Sécurité des appareils de mesure, de commande et de laboratoire.

Cette quatrième édition annule et remplace la troisième édition parue en 2012. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) Il est indiqué que les capteurs de courant utilisés comme APPAREILS INSTALLES A POSTE FIXE ne relèvent pas du domaine d'application du présent document.

b) Les capteurs de courant à fourche ont été ajoutés.

c) Les exigences de la Partie 2-033 applicables aux PINCES MULTIMETRIQUES qui ont pour objectif principal de mesurer la tension sur des RESEAUX sous tension ont été incluses dans la nouvelle Annexe EE normative.

d) Les DISTANCES D'ISOLEMENT et les LIGNES DE FUITE applicables aux EMPLACEMENTS HUMIDES et aux BORNES d'un circuit de mesure dont la tension alternative est supérieure à 1 000 V ou dont la tension continue est supérieure à 1 414 V ont été spécifiées.

e) Il est admis d'utiliser les LIGNES DE FUITE conformes au groupe de matériaux I pour tous les matériaux isolants.

f) Les exigences relatives aux circuits d'entrée/sortie des capteurs de courant de Type A, de Type B et de Type C ont été détaillées en 6.9.102.

g) Les exigences relatives aux cordons des circuits de sortie ont été modifiées.

h) L'essai de choc de la MACHOIRE a été limité à la partie avant des MACHOIRES.

i) L'essai d'abrasion des cordons de capteurs de courant flexibles a été supprimé et remplacé par un essai de pression à haute température.

j) La source de tension utilisée pour l'essai des composants ou des circuits de limitation des surtensions peut être limitée à 400 V.

k) Une référence à l'IEC 61010-031 pour les sondes équipées a été ajoutée.

l) Des exigences permettant d'éviter les SURTENSIONS TRANSITOIRES applicables aux circuits de mesure de tension de RESEAU ont été ajoutées.

m) Des exigences concernant les circuits de mesure entre 1 000 V et 3 000 V ont été ajoutées.

n) Une Annexe CC informative relative aux dimensions des BORNES "banane" a été ajoutée.

o) Un organigramme de l'isolation selon le type de circuit a été ajouté dans une nouvelle Annexe DD.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
66/691/FDIS	66/695/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette Norme internationale.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 61010, sous le titre général *Exigences de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire*, peut être consultée sur le site web de l'IEC.

La présente Partie 2-032 doit être utilisée conjointement avec la dernière édition de l'IEC 61010-1. Elle a été établie sur la base de la troisième édition (2010) de l'IEC 61010-1 et son Amendement 1 (2016), ci-après dénommée la Partie 1.

La présente Partie 2-032 complète ou modifie les articles correspondants de l'IEC 61010-1 de façon à transformer cette publication en norme IEC: *Exigences particulières pour les capteurs de courant, PORTATIFS et manipulés manuellement, pour essai électrique et mesurage*.

Lorsqu'un paragraphe particulier de la Partie 1 n'est pas mentionné dans cette Partie 2-032, ce paragraphe s'applique pour autant que cela soit raisonnable. Lorsque cette Partie 2-032 indique "addition", "modification", "remplacement" ou "suppression", il convient d'adapter en conséquence l'exigence, la modalité d'essai ou la note correspondante de la Partie 1.

Dans la présente norme:

a) les caractères d'imprimerie suivants sont utilisés:
   - exigences: caractères romains;
   - NOTES: petits caractères romains;
   - *conformité et essais: caractères italiques;*
   - termes définis à l'Article 3 et utilisés dans toute cette norme: PETITES CAPITALES EN CARACTERES ROMAINS;

b) les paragraphes, figures, tableaux et notes qui viennent en supplément de ceux de la Partie 1 sont numérotés à partir de 101. Les annexes complémentaires sont numérotées à partir de AA et les listes de termes additionnels à partir de aa).

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

IMPORTANT – Le logo "*colour inside*" qui se trouve sur la page de couverture de cette publication indique qu'elle contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer ce document en utilisant une imprimante couleur.

Le contenu du corrigendum de février 2020 a été pris en considération dans cet exemplaire.

INTRODUCTION

La Partie 2-030 spécifie les exigences de sécurité applicables aux appareils équipés de circuits d'essai et de mesure qui sont connectés à des fins d'essai ou de mesurage à des dispositifs ou à des circuits externes à l'appareil de mesure lui-même. Les exigences de la Partie 2-030 ont été incluses dans cette Partie 2-032. Les appareils qui relèvent des domaines d'application de la Partie 2-030 et de la Partie 2-032 sont considérés comme étant couverts par les exigences de cette Partie 2-032.

La Partie 2-033 spécifie les exigences de sécurité pour les multimètres PORTATIFS qui ont pour objectif principal de mesurer la tension de RESEAUX sous tension. Pour les appareils qui relèvent du domaine d'application de la Partie 2-032 et de la Partie 2-033, seule cette Partie 2-032 s'applique.

La Partie 2-034 spécifie les exigences de sécurité applicables aux appareils de mesure de la résistance d'isolement et aux appareils d'essai de rigidité diélectrique qui sont connectés aux unités, aux lignes ou aux circuits à des fins d'essai ou de mesurage. Pour les appareils qui relèvent du domaine d'application de la Partie 2-032 et de la Partie 2-034, il convient de lire les deux documents conjointement.

EXIGENCES DE SÉCURITÉ POUR APPAREILS ÉLECTRIQUES DE MESURAGE, DE RÉGULATION ET DE LABORATOIRE –

Partie 2-032: Exigences particulières pour les capteurs de courant, PORTATIFS et manipulés manuellement, pour essai électrique et mesurage

1 Domaine d'application et objet

L'article de la Partie 1 est applicable avec les exceptions suivantes:

1.1.1 Appareils inclus dans le domaine d'application

Remplacer le texte existant par le suivant:

La présente partie de l'IEC 61010 spécifie les exigences de sécurité pour les capteurs de courant PORTATIFS et manipulés manuellement décrits ci-dessous.

Ces capteurs de courant sont conçus pour mesurer, détecter ou injecter du courant, ou afficher les formes d'onde du courant sur les circuits sans ouverture physique du chemin du courant sur le circuit mesuré. Les capteurs de courant peuvent être autonomes, ou accessoires d'autres appareils ou parties d'appareils combinés (voir la Figure 101). Cela comprend les circuits de mesure qui font partie des appareils électriques d'essai et de mesure, du matériel de laboratoire ou des appareils de contrôle de procédés industriels. Ces capteurs de courant et circuits nécessitent des moyens de protection supplémentaires entre le capteur de courant, le circuit et un OPERATEUR.

NOTE 1 Un appareil combiné est un appareil connecté électriquement à un capteur de courant au moyen d'une connexion permanente qui peut être déconnectée uniquement à l'aide d'un OUTIL.

NOTE 2 Certains capteurs de courant sont également connus sous les noms de pinces de courant, PINCES MULTIMETRIQUES et sondes de courant.

Les capteurs de courant sont manipulés manuellement avant et/ou après un essai ou un mesurage, mais il n'est pas nécessaire qu'ils soient PORTATIFS pendant l'essai ou le mesurage. Les capteurs de courant utilisés comme APPAREILS INSTALLES A POSTE FIXE ne relèvent pas du domaine d'application du présent document.

Les types suivants de capteurs de courant sont couverts:

a) Type A: capteur de courant conçu pour être mis en place sur ou retiré de CONDUCTEURS NON ISOLES SOUS TENSION DANGEREUSE. Les capteurs de courant de Type A ont des parties PORTATIVES ou manipulées manuellement définies, assurant la protection contre les chocs électriques du conducteur mesuré et ont aussi une protection contre les courts-circuits entre les fils et entre les barres omnibus lors des opérations d'insertion.

b) Type B: capteur de courant avec protection contre les courts-circuits entre les fils ou les barres omnibus lors des opérations d'insertion, mais sans parties PORTATIVES ou manipulées manuellement définies, assurant la protection contre les chocs électriques lors des opérations d'insertion. Des moyens de protection supplémentaires sont nécessaires pour éviter le choc électrique des conducteurs SOUS TENSION DANGEREUSE qui ne peuvent être mis hors service durant la mise en place ou le retrait du capteur de courant.

EXEMPLE 1 Capteurs de courant flexibles.

c) Type C: capteur de courant sans protection contre les courts-circuits entre les fils ou les barres omnibus lors des opérations d'insertion. Les capteurs de courant de Type C sont conçus pour être mis en place sur ou retirés de CONDUCTEURS NON ISOLES SOUS TENSION

DANGEREUSE ou de conducteurs de circuit à énergie non limitée uniquement lorsqu'ils sont mis hors service.

EXEMPLE 2 Transducteurs à noyau ouvrant.

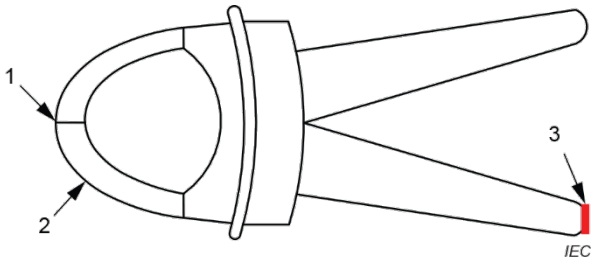
d) Type D: capteur de courant conçu pour être mis en place sur ou retiré de conducteurs isolés ou de conducteurs de circuit à énergie limitée.

EXEMPLE 3 Sondes de courant pour oscilloscopes et détecteurs de courant de fuite à la terre.

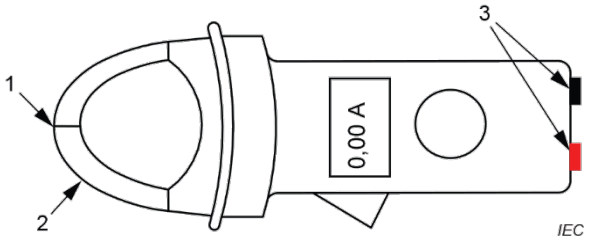
Tous les capteurs de courant peuvent également être utilisés avec des conducteurs isolés. Dans ce cas, les DANGERS sont limités à des niveaux acceptables par l'isolation des conducteurs.

Des exigences complémentaires applicables aux PINCES MULTIMETRIQUES sont données à l'Annexe EE.

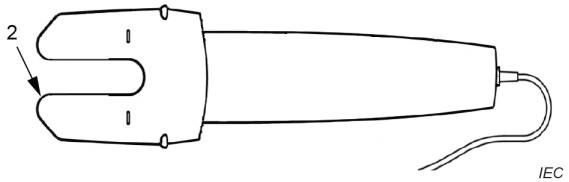
La Figure 101 donne des exemples représentatifs de capteurs de courant type. Les capteurs de courant peuvent être différents selon la conception.



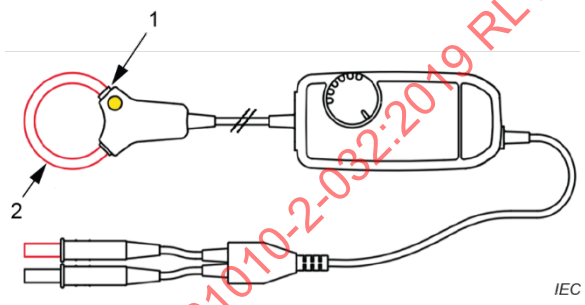
Capteur de courant de Type A utilisé comme accessoire



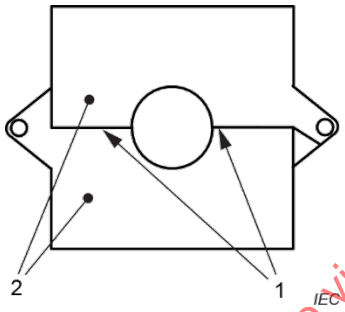
Capteur de courant de Type A avec des fonctions de mesure internes et/ou additionnelles



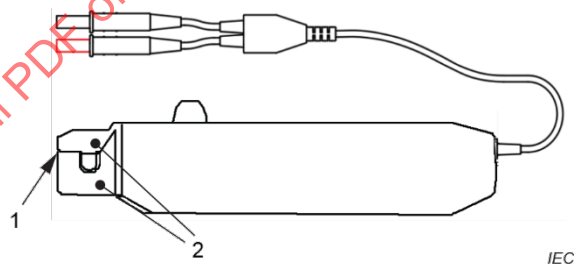
Capteur de courant de Type A avec mâchoires à fourche



Capteur de courant flexible de Type B, partie d'un appareil combiné



Capteur de courant à noyau ouvrant de Type C



Capteur de courant de Type D pour les applications SOUS TENSION non DANGEREUSE (représenté avec une MACHOIRE coulissante)

Légende

1 EXTREMITE(S) de la MACHOIRE

2 MACHOIRE

3 BORNES du circuit de mesure

Figure 101 – Exemples de capteurs de courant et de leurs parties

1.2.1 Aspects inclus dans le domaine d'application

Ajouter les trois nouveaux alinéas suivants à la fin du paragraphe:

Les exigences pour la protection contre les DANGERS résultant d'une UTILISATION NORMALE et d'un MAUVAIS USAGE RAISONNABLEMENT PREVISIBLE de circuits de mesure sont données à l'Article 101.

Les exigences pour la prévention du DANGER d'arc électrique et de courts-circuits sont données à l'Article 102

Les exigences relatives à la confiance dans la valeur affichée des PINCES MULTIMETRIQUES sont données à l'Article EE.5.

2 Références normatives

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

Remplacer "IEC 61010-031" par la nouvelle référence suivante:

IEC 61010-031:2015, *Règles de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire – Partie 031: Exigences de sécurité pour sondes équipées tenues à la main pour mesurage et essais électriques*

Remplacer "IEC 61180-1 (toutes les parties)", "IEC 61180-1" et "IEC 61180-2", par la nouvelle référence suivante:

IEC 61180, *Techniques des essais à haute tension pour matériel à basse tension – Définitions, exigences relatives aux essais, matériel d'essai*

3 Termes et définitions

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

3.1 Appareils et états des appareils

Ajouter les deux nouvelles définitions suivantes:

3.1.101
PORTATIF
destiné à être tenu à la main en UTILISATION NORMALE

3.1.102
PINCE MULTIMETRIQUE
instrument de mesure PORTATIF multifonction et avec plusieurs plages destiné à mesurer le courant d'un RESEAU sous tension sans ouverture physique des conducteurs, la tension d'un RESEAU sous tension et d'autres grandeurs électriques telles que la résistance

3.2 Parties et accessoires

Ajouter les deux nouvelles définitions suivantes:

3.2.101
MACHOIRE
partie d'un capteur de courant qui entoure en totalité ou partiellement le conducteur en essai

3.2.102
EXTREMITE DE LA MACHOIRE
partie de la MACHOIRE dans laquelle l'ouverture se produit lors des opérations d'insertion autour d'un conducteur

3.5 Termes de sécurité

Remplacer la définition de 3.5.4 par la nouvelle définition suivante:

3.5.4
RESEAU
alimentation électrique

Ajouter la nouvelle définition suivante:

3.5.101
CATEGORIE DE MESURE
classification des circuits d'essai et de mesure selon le type de RESEAU auquel ils sont destinés à être connectés

Note 1 à l'article: Les CATEGORIES DE MESURE tiennent compte des CATEGORIES DE SURTENSION, des niveaux des courants de court-circuit, de l'emplacement de l'installation du bâtiment auquel l'essai ou le mesurage doit être réalisé et de certaines dispositions de limitation de l'énergie ou de protection contre les transitoires de l'installation du bâtiment. Voir l'Annexe AA pour de plus amples informations.

3.6 Isolation

Ajouter la nouvelle définition suivante:

3.6.101
CONDUCTEUR NON ISOLE
conducteur non isolé par une isolation solide ou isolé par une isolation solide ne satisfaisant pas aux exigences de l'ISOLATION PRINCIPALE pour la tension pertinente par rapport à la terre

4 Essais

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

4.3.2.5 Alimentation RESEAU

Remplacer le titre et le texte existants par:

4.3.2.5 Alimentation

Les exigences suivantes s'appliquent.

a) La tension d'alimentation RESEAU doit être comprise entre 90 % et 110 % de toute tension d'alimentation ASSIGNEE pour laquelle l'appareil peut être réglé ou, si l'appareil est ASSIGNE pour une fluctuation supérieure, toute tension d'alimentation comprise dans la plage de fluctuation.

b) La fréquence RESEAU doit être toute fréquence ASSIGNEE.

c) Les appareils prévus pour être alimentés en courant alternatif aussi bien qu'en courant continu doivent être connectés à une alimentation en courant alternatif ou en courant continu.

d) La polarité de connexion des appareils prévus pour être alimentés par RESEAU en courant alternatif monophasé doit être à la fois normale et inverse.

e) Si les moyens de connexion permettent une inversion, la polarité de connexion des appareils fonctionnant sur accumulateurs ou piles, et en courant continu doit être à la fois inverse et normale.

4.3.2.6 Tensions d'entrée et de sortie

Remplacer le titre et le texte existants par:

4.3.2.6 Tensions ou courants d'entrée et de sortie

Les tensions ou courants d'entrée et de sortie, y compris les potentiels flottants, mais à l'exclusion de la tension d'alimentation RESEAU, doivent être réglés sur toute tension ou tout courant dans leur plage ASSIGNEE, en polarité normale ou inverse si possible.

4.4.2.8 Sorties

Remplacer le texte existant par le suivant:

Les sorties doivent être ouvertes et court-circuitées à tour de rôle.

5 Marquage et documentation

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

5.1.2 Identification

Ajouter les nouveaux points suivants et un nouvel alinéa après la note du point b):

aa) pour les capteurs de courant conçus uniquement pour une utilisation avec un modèle spécifique d'appareil, le type de l'appareil doit être clairement identifié ou avec le symbole 14 du Tableau 1 si cette information n'est disponible que dans la documentation;

bb) pour les capteurs de courant de Type A, avec le symbole 102 du Tableau 1;

cc) pour les capteurs de courant de Type B et de Type C, avec le symbole 101 du Tableau 1;

dd) pour les capteurs de courant de Type D, avec le symbole 101 et le symbole 14 du Tableau 1.

Le symbole approprié (14, 101 ou 102) doit être marqué près des MACHOIRES ou du marquage de la CATEGORIE DE MESURE des MACHOIRES, si elle est présente (voir 5.1.5.101 et 5.1.5.102).

Tableau 1 – Symboles

Ajouter les deux nouveaux symboles suivants:

Numéro	Symbole	Référence	Description
101			Ne pas mettre en place ou retirer un capteur de courant de CONDUCTEURS NON ISOLES SOUS TENSION DANGEREUSE, ce qui peut entraîner un choc électrique, une brûlure, ou un arc électrique
102		IEC 60417-6300 (2016-03)	La mise en place et le retrait d'un capteur de courant de CONDUCTEURS NON ISOLES SOUS TENSION DANGEREUSE sont autorisés.

5.1.5 BORNES, connexions et dispositifs de manœuvre

Ajouter les deux nouveaux paragraphes suivants:

5.1.5.101 BORNES des circuits de mesure

5.1.5.101.1 Généralités

Sauf comme autorisé en 5.1.5.101.4:

a) la valeur de la tension ASSIGNEE par rapport à la terre des BORNES des circuits de mesure, doit être marquée, et

b) la valeur de la tension ASSIGNEE ou du courant ASSIGNE, selon le cas, de chaque paire ou jeu de BORNES des circuits de mesure prévus pour être utilisés ensemble, doit être marquée, et

c) la CATEGORIE DE MESURE appropriée d'une BORNE, d'une paire ou d'un jeu de BORNES des circuits de mesure, ou le symbole 14 du Tableau 1, doit être marqué comme cela est spécifié en 5.1.5.101.2 et 5.1.5.101.3, le cas échéant.

Les BORNES des circuits de mesure sont habituellement disposées par paires ou jeux. Chaque paire ou jeu de BORNES peut avoir une tension ASSIGNEE ou un courant ASSIGNE, ou les deux, au sein de ce jeu, et chaque BORNE peut avoir individuellement une tension ASSIGNEE par rapport à la terre. Pour certains capteurs de courant, la tension ASSIGNEE entre les BORNES peut être différente de la tension ASSIGNEE par rapport à la terre. Les marquages doivent être clairs pour éviter toute confusion.

Les marquages doivent être placés près des BORNES. Cependant, s'il n'y a pas suffisamment de place (comme sur les capteurs de courant à entrées multiples), le marquage peut être placé sur la plaque signalétique ou sur le cadran, ou le symbole 14 du Tableau 1 peut être apposé sur la BORNE.

Pour chaque jeu de BORNES de circuits de mesure, il n'est pas nécessaire d'apposer le marquage du symbole 14 du Tableau 1 plus d'une fois lorsqu'il est proche des BORNES.

La conformité est vérifiée par examen et, le cas échéant, comme cela est spécifié en 5.1.5.101.2 *et* 5.1.5.101.3*, en tenant compte des exceptions de* 5.1.5.101.4*.*

5.1.5.101.2 BORNES des circuits de mesure dont les catégories de mesure sont des CARACTERISTIQUES ASSIGNEES

La CATEGORIE DE MESURE appropriée doit être marquée pour les BORNES des circuits de mesure dont les CATEGORIES DE MESURE sont des CARACTERISTIQUES ASSIGNEES. Les marquages de la CATEGORIE DE MESURE doivent être "CAT II", "CAT III" ou "CAT IV" selon le cas.

Le marquage de ces BORNES avec plus d'une CATEGORIE DE MESURE et de sa tension ASSIGNEE par rapport à la terre est autorisé.

La conformité est vérifiée par examen.

5.1.5.101.3 BORNES des circuits de mesure ASSIGNEES pour la connexion à des tensions supérieures aux niveaux de 6.3.1

Le symbole 14 du Tableau 1 doit être marqué pour les BORNES des circuits de mesure ASSIGNEES pour la connexion à des tensions supérieures aux niveaux de 6.3.1, mais dont les CATEGORIES DE MESURE ne sont pas des CARACTERISTIQUES ASSIGNEES (voir aussi 5.4.2 bb)).

La conformité est vérifiée par examen.

5.1.5.101.4 BORNES des circuits de mesure connectées en permanence, spécifiques ou pour les TENSIONS non DANGEREUSES

Il n'est pas nécessaire que les BORNES des circuits de mesure fassent l'objet d'un marquage si:

a) elles sont prévues pour être connectées en permanence et non ACCESSIBLES (voir 5.4.3 aa) et bb)), ou

b) elles sont prévues pour être connectées uniquement à des BORNES spécifiques d'autres appareils (voir aussi 6.101.3), ou

c) il est évident, par d'autres indications, que la tension ASSIGNEE est inférieure aux niveaux de 6.3.1.

NOTE Des exemples d'indications acceptables mentionnant que les entrées sont prévues pour être inférieures aux niveaux de 6.3.1 comprennent:

– l'indication de l'échelle totale balayée par l'aiguille d'un voltmètre ou d'un ampèremètre avec une seule plage;

– l'indication de l'échelle maximale portée sur un sélecteur de tension;

– une tension ou une puissance ASSIGNEE exprimée en dB, mW ou W et dont la valeur équivalente décrite dans la documentation est inférieure à 30 V en courant alternatif.

La conformité est vérifiée par examen.

5.1.5.102 Tension et courant ASSIGNES des MACHOIRES

Le marquage des capteurs de courant destinés à être utilisés sur des CONDUCTEURS NON ISOLES doit comporter la valeur de la tension ASSIGNEE par rapport à la terre des MACHOIRES.

Les MACHOIRES de capteurs de courant de Type A, Type B ou Type C et dont les CATEGORIES DE MESURE sont des CARACTERISTIQUES ASSIGNEES, doivent être marquées avec la CATEGORIE DE MESURE appropriée à côté du marquage de la tension par rapport à la terre. Les marquages de la CATEGORIE DE MESURE doivent être "CAT II", "CAT III" ou "CAT IV" selon le cas.

Les MACHOIRES et les BORNES du circuit de sortie des capteurs de courant de Type D ne doivent pas avoir de marquage d'une CATEGORIE DE MESURE.

La valeur du courant ASSIGNE doit être marquée sur ou près des MACHOIRES. La nature du courant doit aussi être marquée à moins que la valeur marquée s'applique à la fois au courant alternatif et au courant continu.

La conformité est vérifiée par examen.

5.4.1 Généralités

Ajouter les nouveaux points suivants à la liste ainsi qu'un nouvel alinéa:

aa) des informations sur chaque CATEGORIE DE MESURE applicable pour le circuit de mesure dont les CATEGORIES DE MESURE sont des CARACTERISTIQUES ASSIGNEES (voir 5.1.5.101.2);

bb) pour les circuits de mesure dont les CATEGORIES DE MESURE ne sont pas des CARACTERISTIQUES ASSIGNEES, mais qui peuvent être improprement connectés à de tels circuits, un avertissement stipulant de ne pas utiliser le capteur de courant pour des mesurages sur le RESEAU, et les CARACTERISTIQUES ASSIGNEES détaillées, y compris les SURTENSIONS TRANSITOIRES (voir AA.2.4 pour de plus amples informations).

Certains capteurs de courant peuvent avoir plusieurs CATEGORIES DE MESURE ASSIGNEES pour un même circuit de mesure. Pour de tels capteurs de courant, la documentation doit clairement identifier les CATEGORIES DE MESURE dans lesquelles le capteur de courant est destiné à être utilisé et celles dans lesquelles il ne doit pas l'être.

5.4.2 CARACTERISTIQUES ASSIGNEES des appareils

Ajouter les deux nouveaux points suivants à la liste ainsi qu'un nouvel alinéa:

aa) des informations sur chaque CATEGORIE DE MESURE applicable pour le circuit de mesure dont les CATEGORIES DE MESURE sont des CARACTERISTIQUES ASSIGNEES (voir 5.1.5.101.2 et 5.1.5.102);

bb) pour les capteurs de courant de Type A, de Type B et de Type C dont les CATEGORIES DE MESURE ne sont pas des CARACTERISTIQUES ASSIGNEES, mais qui peuvent être improprement connectés à de tels circuits, un avertissement stipulant de ne pas utiliser le capteur de courant pour des mesurages sur le RESEAU, et les CARACTERISTIQUES

ASSIGNEES détaillées, y compris les SURTENSIONS TRANSITOIRES (voir AA.2.4 pour de plus amples informations).

Si le capteur de courant comporte plusieurs CATEGORIES DE MESURE ASSIGNEES pour le même circuit de mesure, la documentation doit clairement identifier les CATEGORIES DE MESURE dans lesquelles le capteur de courant est destiné à être utilisé et celles dans lesquelles il ne doit pas l'être.

5.4.3 Installation des appareils

Ajouter les deux nouveaux points suivants à la liste:

aa) pour les BORNES du circuit de mesure prévues pour une connexion permanente et dont les CATEGORIES DE MESURE sont des CARACTERISTIQUES ASSIGNEES, les informations concernant la CATEGORIE DE MESURE, les tensions ou les courants ASSIGNES, selon le cas (voir 5.1.5.101.2 et 5.1.5.102);

bb) pour les BORNES du circuit de mesure prévues pour une connexion permanente et dont les CATEGORIES DE MESURE ne sont pas des CARACTERISTIQUES ASSIGNEES, les informations concernant les tensions, les courants et les SURTENSIONS TRANSITOIRES ASSIGNES, selon le cas (voir 5.1.5.101.4 et 5.1.5.102).

5.4.4 Fonctionnement de l'appareil

Remplacer le texte existant par le suivant:

La notice d'utilisation doit comporter, lorsque cela s'applique:

a) l'identification et la description des dispositifs de commande et leur utilisation dans tous les modes de fonctionnement;

b) pour les capteurs de courant conçus pour une utilisation uniquement avec un modèle spécifique d'appareil, une identification claire du type de l'appareil;

c) les spécifications des limites de fonctionnement intermittent;

d) les spécifications des limites du courant en fonction de la fréquence si le circuit magnétique peut atteindre une température dangereuse;

e) des explications des symboles relatifs à la sécurité, utilisés sur le capteur de courant;

f) les instructions pour l'interconnexion aux accessoires et à d'autres appareils, y compris l'indication des accessoires appropriés et des pièces amovibles;

g) les instructions pour le remplacement des matières consommables;

h) les instructions relatives au nettoyage et à la décontamination;

i) les instructions pour l'application et le retrait du capteur de courant;

j) les instructions pour mettre hors service l'installation sur laquelle le courant est mesuré, ou pour adopter des procédures de fonctionnement sécurisées lorsque le travail est réalisé sur des installations SOUS TENSION DANGEREUSE, durant l'application et le retrait des capteurs de courant de Type B;

k) les instructions pour mettre hors service l'installation sur laquelle le courant est mesuré, lorsque le travail est réalisé sur des installations SOUS TENSION DANGEREUSE ou à énergie non limitée, durant l'application et le retrait des capteurs de courant de Type C;

l) les instructions relatives à la fonction de la BARRIERE DE PROTECTION, indiquant la limite d'accès sécurisé de la partie PORTATIVE;

m) un avertissement à l'OPERATEUR stipulant que les capteurs de courant de Type D ne sont prévus que pour une utilisation autour de conducteurs isolés ou de conducteurs de circuits à énergie limitée;

n) un avertissement à l'OPERATEUR stipulant qu'il convient d'utiliser des équipements de protection individuelle lorsque des parties SOUS TENSION DANGEREUSE peuvent être ACCESSIBLES dans l'installation sur laquelle le mesurage doit être effectué;

o) un avertissement à l'OPERATEUR stipulant de ne pas utiliser un capteur de courant flexible si l'indicateur d'usure du cordon flexible servant de MACHOIRE au capteur de courant flexible est visible (voir 8.103);

p) un avertissement à l'OPERATEUR stipulant de ne pas utiliser un capteur de courant si l'indicateur d'usure de l'EXTREMITE DE LA MACHOIRE est visible (voir 8.104);

q) un avertissement à l'OPERATEUR stipulant de ne pas utiliser un capteur de courant au-dessus de sa fréquence ASSIGNEE, si le circuit magnétique peut atteindre une température dangereuse (voir 10.101).

Les instructions doivent avertir l'OPERATEUR que si le capteur de courant est utilisé d'une façon qui n'est pas spécifiée par le fabricant, la protection assurée par le capteur de courant peut être compromise.

La conformité est vérifiée par examen.

6 Protection contre les chocs électriques

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

6.1.2 Exceptions

Ajouter le nouveau point suivant à la liste:

aa) parties conductrices d'une EXTREMITE DE LA MACHOIRE, à condition qu'elles satisfassent aux exigences de 6.9.101.

6.5.2 LIAISON DE PROTECTION

Remplacer le titre existant par le suivant et supprimer le texte:

6.5.2 Non utilisé

6.6 Connexion aux circuits externes

Ajouter les deux nouveaux paragraphes suivants:

6.6.101 BORNES des circuits de mesure

Les parties conductrices de chaque BORNE non couplée d'un circuit de mesure qui peuvent devenir SOUS TENSION DANGEREUSE lorsque la tension ASSIGNEE la plus élevée est appliquée aux autres BORNES du circuit de mesure du capteur de courant doivent être séparées:

a) de la partie la plus proche du doigt d'épreuve touchant les parties extérieures de la BORNE dans la position la plus défavorable, par au moins la DISTANCE D'ISOLEMENT et la LIGNE DE FUITE applicables du Tableau 101 pour les BORNES ayant une tension ASSIGNEE qui peut atteindre 1 000 V en courant alternatif ou 1 500 V en courant continu (voir Figure 1);

b) de la partie la plus proche du doigt d'épreuve touchant les parties extérieures de la BORNE dans la position la plus défavorable, par au moins 2,8 mm pour la DISTANCE D'ISOLEMENT et la LIGNE DE FUITE pour les BORNES ayant une tension ASSIGNEE supérieure à 1 000 V en courant alternatif ou 1 500 V en courant continu. Ces BORNES doivent également résister à l'essai en tension de 6.8 avec une tension d'essai égale à la tension ASSIGNEE de la BORNE multipliée par 1,25 et appliquée entre la partie la plus proche du doigt d'épreuve touchant les parties extérieures de la BORNE dans la position la plus défavorable et les BORNES du circuit de mesure.

EXEMPLE Pour une tension alternative ASSIGNEE de 4 000 V (valeur efficace), la tension d'essai alternative est de 5 000 V (valeur efficace) (valeur crête de 7 070 V). La DISTANCE D'ISOLEMENT calculée est de 13,1 mm selon D_2 du Tableau K.15. Pour les champs homogènes, une DISTANCE D'ISOLEMENT moins élevée peut être obtenue au moyen d'essais (voir l'IEC 60664-1 pour de plus amples informations sur les champs homogènes).

c) en ce qui concerne les EMPLACEMENTS HUMIDES, aucune exigence relative à la DISTANCE D'ISOLEMENT et à la LIGNE DE FUITE n'est prévue pour les tensions comprises entre 16 V (valeur efficace) en courant alternatif et 30 V (valeur efficace) en courant alternatif, ou entre 35 V en courant continu et 60 V en courant continu. Néanmoins, les parties conductrices des BORNES non couplées d'un circuit de mesure ne doivent pas être ACCESSIBLES.

Tableau 101 – DISTANCES D'ISOLEMENT et LIGNES DE FUITE des BORNES d'un circuit de mesure ayant des parties conductrices sous TENSION DANGEREUSE qui peuvent atteindre 1 000 V en courant alternatif ou 1 500 V en courant continu

Tension des parties conductrices de la BORNE V en courant alternatif (valeur efficace) et V en courant continu	DISTANCE D'ISOLEMENT et LIGNE DE FUITE mm
≥ 30 ≤ 300	0,8
> 300 ≤ 600	1,0
> 600 ≤ 1 000	2,0
> 1 000 ≤ 1 500 [a]	2,8
NOTE Les valeurs présentées dans ce tableau ne s'appliquent pas aux tensions inférieures aux TENSIONS dangereuses (voir 6.3.1 a)). [a] Pour la tension continue uniquement.	

L'Annexe CC fournit des informations concernant les dimensions recommandées des BORNES "banane" de 4 mm.

La conformité est vérifiée par examen, par la détermination des parties ACCESSIBLES, par mesurage des DISTANCES D'ISOLEMENT et LIGNES DE FUITE applicables, et le cas échéant, par l'essai en tension de 6.8.

6.6.102 BORNES spécialisées des circuits de mesure

Les composants, les capteurs et les dispositifs prévus pour être connectés à des BORNES spécialisées des circuits de mesure ne doivent pas être à la fois ACCESSIBLES et SOUS TENSION DANGEREUSE, que ce soit en CONDITION NORMALE ou en CONDITION DE PREMIER DEFAUT, même lorsque la tension ASSIGNEE la plus élevée est appliquée à toute autre BORNE du circuit de mesure.

NOTE Ces BORNES spécialisées incluent entre autres les BORNES de mesure de semiconducteurs, de condensateurs et les connecteurs de thermocouple.

La conformité est vérifiée par examen et mesurage. Les composants, capteurs et dispositifs prévus pour être connectés aux BORNES spécialisées d'un circuit de mesure sont connectés. Les mesurages de 6.3 sont effectués afin de garantir que les niveaux de 6.3.1 et de 6.3.2 ne sont pas dépassés lorsque chacune des tensions suivantes est appliquée à chaque BORNE du circuit de mesure, le cas échéant:

a) la tension alternative ASSIGNEE la plus élevée à toute fréquence RESEAU ASSIGNEE;

b) la tension continue ASSIGNEE la plus élevée;

c) la tension alternative ASSIGNEE la plus élevée à la fréquence de mesure maximale ASSIGNEE associée.

6.7.1.3 LIGNES DE FUITE

Ajouter le nouvel alinéa suivant après le troisième alinéa:

Pour les APPAREILS PORTATIFS non alimentés par le RESEAU ou le circuit de mesure, il est admis d'utiliser les LIGNES DE FUITE conformes au groupe de matériaux I pour les autres matériaux.

Pour les BORNES des APPAREILS PORTATIFS prévus pour être connectés uniquement à une sonde équipée portative conforme à la Partie 031, il est admis d'utiliser les LIGNES DE FUITE conformes au groupe de matériaux I pour l'isolation des BORNES.

6.7.1.5 Exigences pour l'isolation suivant le type de circuit

Remplacer le texte existant par le suivant:

Les exigences pour l'isolation de types particuliers de circuits sont spécifiées comme suit:

a) en 6.7.2 pour les CIRCUITS RESEAU en CATEGORIE DE SURTENSION II avec une tension d'alimentation nominale jusqu'à 300 V;

NOTE 1 Voir l'Annexe I pour les tensions nominales des RESEAUX de distribution.

b) en 6.7.3 pour les circuits secondaires séparés des circuits du a) au moyen seulement d'un transformateur;

c) à l'Article K.1 pour les CIRCUITS RESEAU en CATEGORIE DE SURTENSION III ou IV ou en CATEGORIE DE SURTENSION II au-delà de 300 V;

d) à l'Article K.2 pour les circuits secondaires séparés des circuits du c) au moyen seulement d'un transformateur;

e) à l'Article K.3 pour les circuits ayant une ou plusieurs des caractéristiques suivantes:

   1) la SURTENSION TRANSITOIRE maximale possible est limitée par la source d'alimentation ou à l'intérieur du capteur de courant à une valeur connue inférieure aux valeurs prises par hypothèse pour le CIRCUIT RESEAU;
   2) la SURTENSION TRANSITOIRE maximale possible est supérieure aux valeurs prises par hypothèse pour le CIRCUIT RESEAU;
   3) la TENSION DE SERVICE est la somme des tensions de plusieurs circuits, ou est une tension mixte;
   4) la TENSION DE SERVICE comporte une tension de crête répétitive qui peut comprendre une forme d'onde périodique non sinusoïdale ou une forme d'onde non périodique survenant régulièrement;
   5) la TENSION DE SERVICE a une fréquence supérieure à 30 KHz;
   6) le circuit est un circuit de mesure pour lequel les CATEGORIES DE MESURE ne s'appliquent pas.

f) à l'Article K.101 pour les circuits de mesure dont les CATEGORIES DE MESURE sont des CARACTERISTIQUES ASSIGNEES.

NOTE 2 Ces exigences sont représentées dans l'organigramme de l'Annexe DD, Figure DD.1.

Le niveau de SURTENSION TRANSITOIRE pour le RESEAU correspond à la valeur spécifiée de "tension ASSIGNEE de tenue aux chocs exigée des équipements" du Tableau 443.2 de l'IEC 60364-4-44:2007/AMD1:2015.

6.8.3.1 Essai en tension alternative

Remplacer la première phrase par la phrase suivante:

Le générateur de tension doit pouvoir maintenir la tension d'essai à ±5 % de la valeur spécifiée tout au long de l'essai.

6.9 Exigences relatives à la construction pour la protection contre les chocs électriques

Ajouter les deux nouveaux paragraphes suivants:

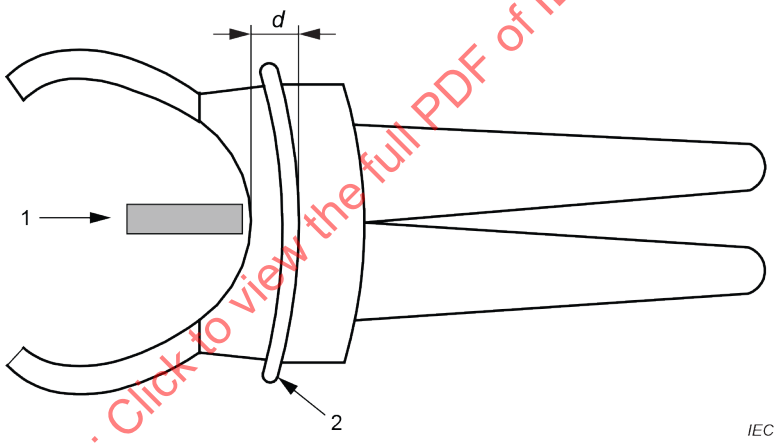
6.9.101 Protection contre le conducteur SOUS TENSION DANGEREUSE

6.9.101.1 Protection par une BARRIERE DE PROTECTION

Pour réduire le RISQUE pour l'OPERATEUR de toucher le conducteur SOUS TENSION DANGEREUSE lors des opérations d'insertion ou lors d'un mesurage, les capteurs de courant de Type A doivent être équipés d'une BARRIERE DE PROTECTION afin d'avertir l'OPERATEUR de la limite d'accès sécurisé. La BARRIERE DE PROTECTION doit couvrir au moins 50 % du périmètre et doit s'étendre au moins sur deux côtés opposés de la partie PORTATIVE.

La DISTANCE D'ISOLEMENT et la LIGNE DE FUITE entre les parties SOUS TENSION DANGEREUSE et la BARRIERE DE PROTECTION doivent satisfaire aux exigences de l'ISOLATION RENFORCEE pour les CARACTERISTIQUES ASSIGNEES des MACHOIRES. La Figure 102 donne un exemple de la DISTANCE D'ISOLEMENT "*d*" entre la BARRIERE DE PROTECTION, les MACHOIRES et le conducteur SOUS TENSION DANGEREUSE.

La conformité est vérifiée par examen et mesurage des DISTANCES D'ISOLEMENT et des LIGNES DE FUITE.



Légende

1 Conducteur SOUS TENSION DANGEREUSE

2 BARRIERE DE PROTECTION

d Distance entre la BARRIERE DE PROTECTION et le conducteur SOUS TENSION DANGEREUSE

Figure 102 – DISTANCE D'ISOLEMENT entre la BARRIERE DE PROTECTION, les MACHOIRES et le conducteur SOUS TENSION DANGEREUSE

6.9.101.2 Parties PORTATIVES ou manipulées manuellement

Les parties PORTATIVES ou manipulées manuellement des capteurs de courant de Type A doivent être séparées par une DOUBLE ISOLATION ou par une ISOLATION RENFORCEE des parties des MACHOIRES qui peuvent être touchées par un CONDUCTEUR NON ISOLE, en position ouverte et fermée. Toute partie conductrice du circuit magnétique qui peut être en contact avec un conducteur est considérée comme portée à la tension ASSIGNEE des MACHOIRES par rapport à la terre.

Les EXTREMITES DE MACHOIRES qui comportent un indicateur d'usure doivent avoir au moins une DOUBLE ISOLATION ou une ISOLATION RENFORCEE lorsqu'elles sont neuves, et au moins une ISOLATION PRINCIPALE lorsque l'indicateur d'usure apparaît.

La conformité est vérifiée par examen, par la détermination des parties ACCESSIBLES des MACHOIRES en position ouverte et fermée au moyen de la broche métallique décrite en 6.2.3 et par la détermination des parties PORTATIVES ou manipulées manuellement ACCESSIBLES, et,

a) pour le capteur de courant dont les CATEGORIES DE MESURE sont des CARACTERISTIQUES ASSIGNEES, par mesurage des valeurs applicables aux DISTANCES D'ISOLEMENT et aux LIGNES DE FUITE définies en K.101.2 et K.101.3, et par les essais applicables de K.101.4 pour l'isolation solide;

b) pour le capteur de courant dont les CATEGORIES DE MESURE ne sont pas des CARACTERISTIQUES ASSIGNEES, par mesurage des valeurs applicables aux DISTANCES D'ISOLEMENT et aux LIGNES DE FUITE définies en K.3.2 ou K.3.3 et K.3.4, et par les essais applicables de K.3.5 pour l'isolation solide.

NOTE La broche d'essai métallique simule un CONDUCTEUR NON ISOLE.

Outre la broche métallique, les surfaces extérieures de l'ENVELOPPE des MACHOIRES sont recouvertes d'une feuille de métal en position ouverte et fermée pendant l'essai.

Si les EXTREMITES DE MACHOIRES des capteurs de courant de Type A dont les CATEGORIES DE MESURE III et IV sont des CARACTERISTIQUES ASSIGNEES, comportent un indicateur d'usure, le mesurage et les essais sont réalisés à la fois avant et après l'essai d'abrasion des EXTREMITES DE MACHOIRES de 8.101 et l'essai de choc de la MACHOIRE de 8.102, le cas échéant.

Si les EXTREMITES DE LA MACHOIRE ne comportent pas d'indicateur d'usure, le mesurage et les essais sont réalisés après l'essai d'abrasion des EXTREMITES DE MACHOIRES de 8.101 et l'essai de choc de la MACHOIRE de 8.102, le cas échéant.

6.9.102 Circuits d'entrée/sortie

Les circuits d'entrée/sortie des capteurs de courant de Type A, de Type B et de Type C doivent être séparés par une DOUBLE ISOLATION ou par une ISOLATION RENFORCEE des parties des MACHOIRES qui peuvent être touchées par un CONDUCTEUR NON ISOLE, en position ouverte et fermée. Toute partie conductrice du circuit magnétique qui peut être en contact avec un conducteur est considérée comme portée à la tension ASSIGNEE des MACHOIRES par rapport à la terre.

Les EXTREMITES DE MACHOIRES qui comportent un indicateur d'usure doivent avoir au moins une DOUBLE ISOLATION ou une ISOLATION RENFORCEE lorsqu'elles sont neuves, et au moins une ISOLATION PRINCIPALE lorsque l'indicateur d'usure apparaît.

La conformité est vérifiée par examen, par la détermination des parties ACCESSIBLES des MACHOIRES en position ouverte et fermée au moyen de la broche métallique décrite en 6.2.3 et,

a) pour le capteur de courant dont les CATEGORIES DE MESURE sont des CARACTERISTIQUES ASSIGNEES, par mesurage des valeurs applicables aux DISTANCES D'ISOLEMENT et aux LIGNES DE FUITE définies en K.101.2 et K.101.3, et par les essais applicables de K.101.4 pour l'isolation solide;

b) pour le capteur de courant dont les CATEGORIES DE MESURE ne sont pas des CARACTERISTIQUES ASSIGNEES, par mesurage des valeurs applicables aux DISTANCES D'ISOLEMENT et aux LIGNES DE FUITE définies en K.3.2 ou K.3.3 et K.3.4, et par les essais applicables de K.3.5 pour l'isolation solide.

NOTE La broche d'essai métallique simule UN CONDUCTEUR NON ISOLE.

Outre la broche métallique, les surfaces extérieures de l'ENVELOPPE des MACHOIRES sont recouvertes d'une feuille de métal en position ouverte et fermée.

Si les EXTREMITES DE MACHOIRES comportent un indicateur d'usure, le mesurage et les essais sont réalisés à la fois avant et après l'essai d'abrasion des EXTREMITES DE LA MACHOIRE de 8.101 et l'essai de choc de la MACHOIRE de 8.102, le cas échéant.

Si les EXTREMITES DE LA MACHOIRE ne comportent pas d'indicateur d'usure, le mesurage et les essais sont réalisés après l'essai d'abrasion des EXTREMITES DE MACHOIRES de 8.101 et l'essai de choc de la MACHOIRE de 8.102, le cas échéant.

Ajouter le nouveau paragraphe suivant:

6.101 Cordons des circuits de sortie

6.101.1 Généralités

Les surfaces extérieures des cordons des circuits de sortie des capteurs de courant peuvent facilement toucher les parties SOUS TENSION DANGEREUSE de l'installation en essai. Les conducteurs internes des cordons des circuits de sortie des capteurs de courant peuvent également être maintenus à une TENSION DANGEREUSE lorsqu'ils sont connectés à un appareil de mesure ou de commande (wattmètre, analyseur de qualité de l'énergie...).

6.101.2 Connexion à l'ENVELOPPE du capteur de courant

Les BORNES couplées situées sur l'ENVELOPPE du capteur de courant et/ou les cordons doivent avoir une DOUBLE ISOLATION ou une ISOLATION RENFORCEE entre leurs surfaces extérieures et leurs conducteurs.

Pour les capteurs de courant de Type A, de Type B et de Type C, l'isolation des cordons des circuits de sortie, et des BORNES couplées est fondée sur les exigences de l'Article K.101 pour la valeur la plus élevée de la tension ASSIGNEE et de la CATEGORIE DE MESURE des MACHOIRES ou les CARACTERISTIQUES ASSIGNEES du circuit de sortie, mais pas moins de 300 V en CATEGORIE DE MESURE II.

Pour les capteurs de courant de Type D, l'isolation des cordons des circuits de sortie et des BORNES couplées est fondée sur les exigences de l'Article K.101 pour 300 V en CATEGORIE DE MESURE II.

La conformité est vérifiée par examen, par mesurage des valeurs applicables des DISTANCES D'ISOLEMENT et des LIGNES DE FUITE définies en K.101.2 et par les essais applicables de K.101.4 pour l'isolation solide.

6.101.3 Connexion à un appareil de mesure ou de commande

Le fabricant doit attribuer une valeur de tension et préciser si une CATEGORIE DE MESURE est ASSIGNEE pour cette connexion.

Le présent document n'exige aucune tension ASSIGNEE minimale pour les BORNES de capteur de courant destinées à être connectées à un appareil de mesure ou de commande.

Les BORNES non couplées doivent satisfaire aux exigences de 101.2.

Si le capteur de courant a été conçu pour être utilisé uniquement avec un modèle spécifique d'appareil, les VALEURS ASSIGNEES des BORNES du capteur doivent être conformes aux VALEURS ASSIGNEES des BORNES de cet appareil de mesure ou de commande spécifique.

La conformité est vérifiée comme cela est spécifié en 101.2, par examen, et,

a) pour le capteur de courant dont les CATEGORIES DE MESURE *sont des* CARACTERISTIQUES ASSIGNEES, *par mesurage des valeurs applicables aux* DISTANCES D'ISOLEMENT *et aux* LIGNES DE FUITE *définies en K.101.2 et K.101.3, et par les essais applicables de K.101.4 pour l'isolation solide;*

b) pour le capteur de courant dont les CATEGORIES DE MESURE *ne sont pas des* CARACTERISTIQUES ASSIGNEES, *par mesurage des valeurs applicables aux* DISTANCES D'ISOLEMENT *et aux* LIGNES DE FUITE *définies en K.3.2 ou K.3.3 et K.3.4, et par les essais applicables de K.3.5 pour l'isolation solide.*

7 Protection contre les DANGERS mécaniques

L'article de la Partie 1 est applicable.

8 Résistance aux contraintes mécaniques

L'article de la Partie 1 est applicable à l'exception de ce qui suit.

Ajouter les quatre nouveaux paragraphes suivants:

8.101 Essai d'abrasion des EXTREMITES DE MACHOIRES

Lorsque les capteurs de courant sont mis en place sur ou retirés des conducteurs, leurs EXTREMITES DE MACHOIRES peuvent être soumises à l'abrasion, notamment lorsque le conducteur est une barre omnibus. Ces capteurs de courant doivent être conçus de manière à être sûrs après l'essai suivant d'abrasion des EXTREMITES DE MACHOIRES, réalisé afin de simuler l'usure des MACHOIRES lors des opérations d'insertion et de retrait. Cette exigence est applicable uniquement aux capteurs de courant de Type A et de Type B dont les CATEGORIES DE MESURE III et IV sont des CARACTERISTIQUES ASSIGNEES. Les capteurs de courant avec une MACHOIRE coulissante, les capteurs de courant avec des MACHOIRES à fourche et les capteurs de courant flexibles ne sont pas concernés par 8.101.

Les EXTREMITES DE MACHOIRES peuvent comporter un indicateur d'usure qui permet de visualiser la limite d'utilisation après abrasion. Un indicateur d'usure est une fonction comportant une couleur contrastée qui apparaît quand une certaine limite d'usure est atteinte.

Un échantillon non conditionné de capteur de courant en CONDITION NORMALE *et un échantillon préconditionné du capteur de courant conditionné comme cela est spécifié en 10.5.2 a) sont traités comme suit.*

Une plaque constituée par un matériau rigide recouvert sur les deux faces d'une toile émeri est préparée. La plaque a une surface minimale de 50 mm par 450 mm et une épaisseur de 2 mm au maximum. La toile émeri doit avoir un grain N° 120, à support en toile et revêtement incorporant un abrasif à l'oxyde d'aluminium.

Les mâchoires ouvertes, les échantillons sont insérés comme indiqué par la Figure 103, puis les mâchoires sont fermées.

Les échantillons sont déplacés le long de la plaque sur une distance de 200 mm, ou moins, du fait de sa conception, pendant 50 cycles – un cycle correspondant à un mouvement aller et à un mouvement retour – afin d'user le point de fermeture des mâchoires (voir la Figure 103). Si l'isolation des extrémités de mâchoires comporte un indicateur d'usure, l'essai est terminé lorsque l'indicateur d'usure apparaît avant la fin des 50 cycles. La toile émeri est remplacée après le traitement de chaque échantillon.

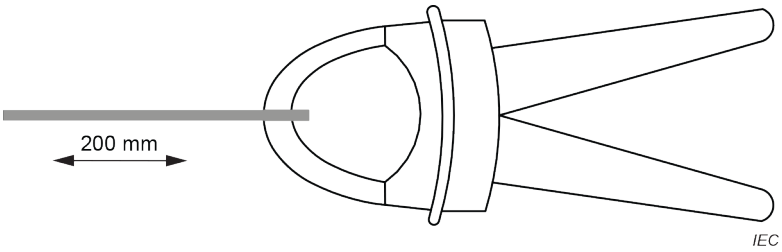


Figure 103 – Essai d'abrasion des EXTREMITES DE MACHOIRES

Après l'essai d'abrasion, les échantillons de capteur de courant sont soumis à la déclaration de conformité de 6.9.101.2 et 6.9.102.

8.102 Essai de choc de la MACHOIRE

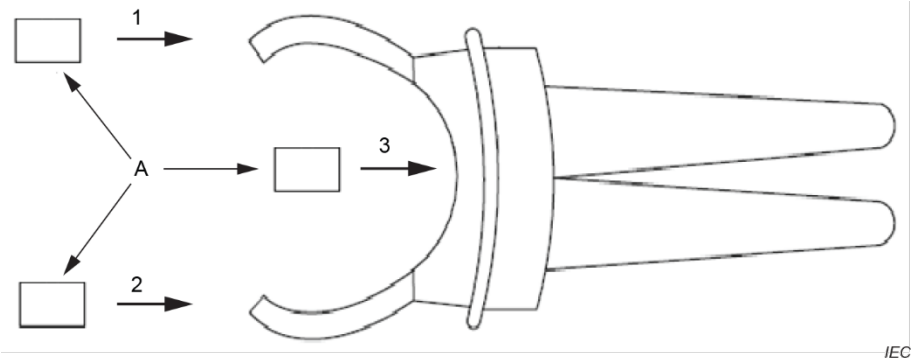
Lorsque les capteurs de courant sont mis en place sur ou retirés des conducteurs, ils peuvent les heurter et être endommagés, notamment lorsque le conducteur est une barre omnibus. Ces capteurs de courant doivent être conçus de manière à être sûrs après l'essai suivant de choc de la MACHOIRE, réalisé afin de simuler la contrainte des MACHOIRES lors de l'opération d'insertion. Cette exigence est applicable uniquement aux capteurs de courant de Type A dont les CATEGORIES DE MESURE III et IV sont des CARACTERISTIQUES ASSIGNEES, sauf pour les capteurs de courant flexibles. Le niveau normal d'énergie exigé pour la protection pour l'essai de choc est issu du Tableau 102.

L'essai est effectué sur un échantillon de capteur de courant. L'échantillon est soumis à l'essai conformément à la norme IEC 60068-2-75 par l'essai Eha (marteau pendulaire), par l'essai Ehb (marteau à ressort) ou par l'essai Ehc (marteau vertical) avec le niveau d'énergie déterminé dans le Tableau 102 selon la masse du capteur de courant.

Tableau 102 – Niveau d'énergie pour l'essai de choc de la MACHOIRE

Masse du capteur de courant kg	**Niveau d'énergie** J	**Code IK** (IEC 62262)
≤ 0,5	1	IK06
> 0,5 ≤ 1	2	IK07
> 1	5	IK08

L'échantillon est refroidi à la température ambiante minimale ASSIGNEE pendant au moins 4 h, puis soumis à l'essai dans les 3 min. L'échantillon est fermement maintenu sur un support rigide et ouvert dans toute la mesure du possible. Trois points sont soumis à l'essai, deux points se situant sur les surfaces extérieures des MACHOIRES à proximité des EXTREMITES DE MACHOIRES, le troisième point se situant sur la surface intérieure du capteur directement opposée à l'ouverture (voir Figure 104). Le nombre de chocs est d'un par point.



Légende

A Marteau

1, 2, 3 Direction du choc

Figure 104 – Points de choc pour l'essai de choc de la MACHOIRE

Après l'essai de choc de la MACHOIRE, l'échantillon de capteur de courant est porté à une température d'essai de référence (voir 4.3.1) et soumis à la déclaration de conformité de 6.9.101.2 et 6.9.102.

8.103 Essai de pression à haute température pour l'isolation des capteurs de courant flexibles

Les cordons flexibles utilisés pour la MACHOIRE d'un capteur de courant flexible ne doivent pas provoquer un DANGER lorsqu'ils sont soumis à une contrainte mécanique susceptible de se produire en UTILISATION NORMALE. Pour satisfaire à cette exigence, les cordons flexibles doivent être conçus pour être sûrs après l'essai de pression suivant, réalisé afin de simuler la contrainte des cordons flexibles lors de leur utilisation.

Les cordons flexibles peuvent comporter un indicateur d'usure qui permet de visualiser la limite d'utilisation. Un indicateur d'usure est une fonction comportant une couleur contrastée qui apparaît quand une certaine limite d'usure est atteinte.

Les cordons flexibles doivent assurer au moins une DOUBLE ISOLATION ou une ISOLATION RENFORCEE lorsqu'ils sont neufs. De plus, ils doivent satisfaire aux conditions suivantes:

a) S'ils ne comportent pas d'indicateur d'usure, ils doivent assurer au moins une DOUBLE ISOLATION ou une ISOLATION RENFORCEE après une usure de durée de vie type.

b) S'ils comportent un indicateur d'usure, ils doivent assurer au moins une ISOLATION PRINCIPALE lorsque l'indicateur d'usure apparaît.

La conformité est vérifiée par les essais suivants:

Trois échantillons du cordon flexible sont soumis à l'essai. Chaque échantillon est prélevé sur un capteur de courant flexible dont la longueur est comprise entre 150 mm et 300 mm. La longueur de chaque échantillon est comprise entre 50 mm et 100 mm.

Le dispositif de pénétration est représenté à la Figure 105, et se compose d'une lame rectangulaire avec un coin de 0,70 mm ± 0,01 mm de large, qui peut être pressé contre l'échantillon. Chaque échantillon est placé dans la position représentée à la Figure 105. Un cordon flexible plat sans gaine est couché sur son côté plat. Les échantillons sont fixés sur le support de manière à ne pas se courber sous la pression de la lame. La force est appliquée dans la direction perpendiculaire à l'axe de l'échantillon; la lame est également perpendiculaire à l'axe de l'échantillon.