BS EN 61010-2-032:2012

BSI Standards Publication

Safety requirments 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

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National foreword

This British Standard is the UK implementation of EN 61010-2-032:2012. It is identical to IEC 61010-2-032:2012. It supersedes BS EN 61010-2-032:2002 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/66, Safety of measuring, control and laboratory equipment.

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

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

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

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English version

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 61010-2-032:2012)

Règles 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 à la main, de test et de mesure électriques
(CEI 61010-2-032:2012)

Sicherheitsbestimmungen für elektrische Mess-, Steuer-, Regel- und Laborgeräte – Teil 2-032: Besondere Anforderungen für handgehaltene und handbediente Stromsonden für elektrische Prüfungen und Messungen
(IEC 61010-2-032:2012)

CENELEC

European Committee for Electrotechnical Standardization
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Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 66/474/FDIS, future edition 3 of IEC 61010-2-032, prepared by IEC/TC 66, "Safety of measuring, control and laboratory equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61010-2-032:2012.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2013-07-31
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2015-10-31

This document supersedes EN 61010-2-032:2002.

EN 61010-2-032:2012 includes the following significant technical changes with respect to EN 61010-2-032:2002:
a) A new Type D current sensor has been defined.
b) The terminology for MEASUREMENT CATEGORY I has changed. In this Part 2-032, it is termed “not RATED for measurements within MEASUREMENT CATEGORIES II, III, or IV”.
c) Requirements for markings of measuring circuit TERMINALS and JAWS have been modified.
d) CLEARANCES and CREEPAGE DISTANCES have been added for unmated measuring circuit TERMINALS.
e) Requirements have been added for specialized measuring circuit TERMINALS.
f) The pull test for endcaps of flexible current sensors has been revised.
g) Requirements for output circuit leads have been revised.
h) Requirements have been added for temperature limits and resistance to heat to prevent thermal HAZARDS from eddy currents and high currents.
i) Requirements for circuits or components used as TRANSIENT OVERVOLTAGE limiting devices have been revised.
j) Requirements have been added for low battery indication.
k) Requirements have been revised and added pertaining to REASONABLY FORESEEABLE MISUSE of measuring circuits, including usage of the current sensor in a manner that might cause arc flash.
l) Requirements for MAINS voltage measuring circuits have been added.
m) Requirements to prevent HAZARDs from short-circuits have been revised and located in a new Clause 102.
n) ROUTINE TESTS have been modified.
o) Insulation requirements for measuring circuits have been primarily located in Annex K.
p) Annex AA has been added to describe the characteristics of MEASUREMENT CATEGORIES.
q) Annex BB has been added to describe HAZARDS that may be encountered when using measuring circuits.

EN 61010-2-032:2012 is to be used in conjunction with EN 61010-1:2010, on the basis of which It was established. Consideration may be given to future editions of, or amendments to, EN 61010-1.

This Part 2-032 supplements or modifies the corresponding clauses in EN 61010-1 so as to convert that publication into the European Standard: *Particular requirements for HAND-HELD MULTIMETERS and other METERS, for domestic and professional use, capable of measuring MAINS voltage.*

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 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 test: 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; and additional list items are numbered from aa). Additional annexes are numbered AA and BB.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC)

Endorsement notice

The text of the International Standard IEC 61010-2-032:2012 was approved by CENELEC as a European Standard without any modification.

Add the following reference to the bibliography of EN 61010-1:

IEC 61010-2-033	NOTE	Harmonized as EN 61010-2-033.

CONTENTS

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 HAND HELD 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 Part 2-032 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.

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

Replacement:

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 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 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 2 Some current sensors are also known as current clamps and current probes.

Current sensors require hand manipulation before or after a test or measurement, but do not necessarily need to be HAND-HELD during the test or measurement.

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 or removed from UNINSULATED HAZARDOUS LIVE 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 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 conductors or from non-limited-energy circuit conductors only when they are de-energised.

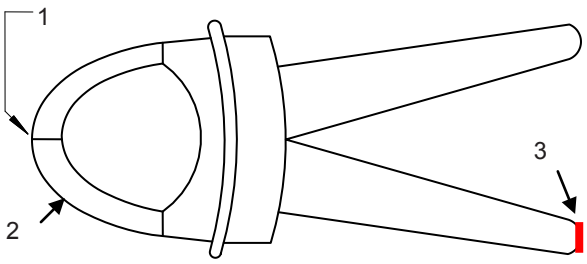
EXAMPLE 2 Split-core transducers.

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

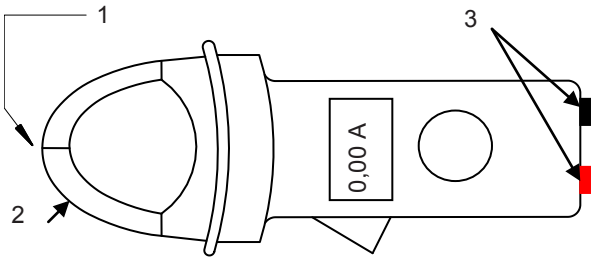
A Type D current sensor does not need protection against short-circuits during clamping and has no defined HAND-HELD or hand-manipulated parts providing protection against electric shock from the conductor being measured.

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

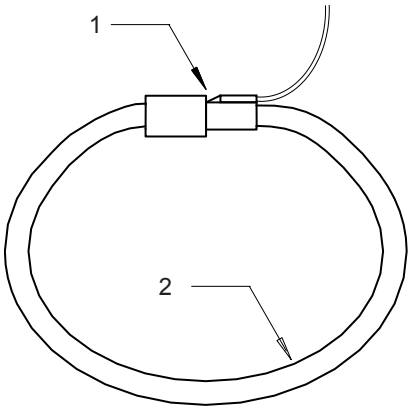
NOTE 4 All current sensors can also be used around insulated conductors. In this case, HAZARDS are limited to acceptable levels by the insulation of the conductors.



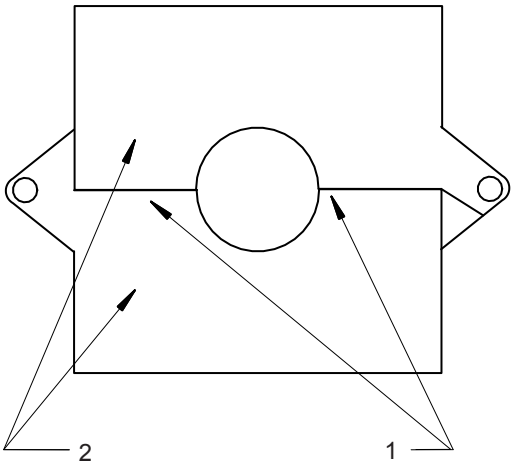
Type A
Current sensor as an accessory



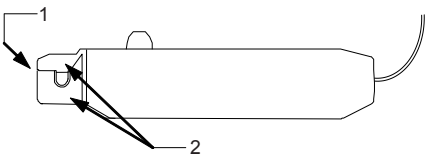
Type A
Current sensor with self-contained measuring functions or with additional measuring functions



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

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

Addition:

Add the following two 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.

2 Normative references

This clause of Part 1 is applicable.

3 Terms and definitions

This clause of Part 1 is applicable except as follows:

3.1 Equipment and states of equipment

Addition:

Add the following new definition:

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

3.2 Parts and accessories

Addition:

Add the following new 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

Replacement:

Replace the definitions of 3.5.4 and 3.5.5 with the following new definitions:

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

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

Addition:

Add the following new 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 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

Addition:

Add the following new definition:

3.6.101
UNINSULATED
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:

4.4.2.8 Outputs

Replacement:

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

Addition:

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;

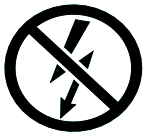
dd) for Type D current sensors, symbol 101 of Table 1 is permitted with an additional marking (see 5.1.5.102).

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

Table 1 – Symbols

Addition:

Add the following new symbols:

Number	Symbol	Reference	Description
101			Do not apply around or remove from UNINSULATED HAZARDOUS LIVE conductors, which may render electric shock, electric burn, or arc flash
102			Application around and removal from UNINSULATED HAZARDOUS LIVE conductors is permitted

5.1.5 TERMINALS, connections and operating devices

Addition:

Add the following 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, 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), 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 measuring circuit TERMINALS 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 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 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, 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 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. 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.

5.4.2 Equipment RATINGS

Addition:

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 for MEASUREMENT CATEGORY II, III or IV (see 5.1.5.101.2 and 5.1.5.102);

bb) for current sensors that do not have a RATING for MEASUREMENT CATEGORY II, III or IV, but 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 not be used.

5.4.3 Equipment installation

Addition:

Add the following two new items to the list:

aa) for measuring circuit TERMINALS intended for permanent connection and 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 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 and 5.1.5.102).

5.4.4 Equipment operation

Replacement:

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;

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);

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);

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

Addition:

Add the following new item aa):

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

6.5.2 PROTECTIVE BONDING

Replacement:

Replace the title and text with:

6.5.2 (Void)

6.6 Connections to external circuits

Addition:

Add the following new subclauses:

6.6.101 Measuring circuit TERMINALS

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 shall be separated by at least 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).

Table 101 – CLEARANCES and CREEPAGE DISTANCES for measuring circuit TERMINALS with HAZARDOUS LIVE conductive parts

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)).		

Conformity is checked by inspection and measurement.

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 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 maximum RATED measurement frequency.

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)

6.9 Constructional requirements for protection against electric shock

Addition:

Add the following 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.

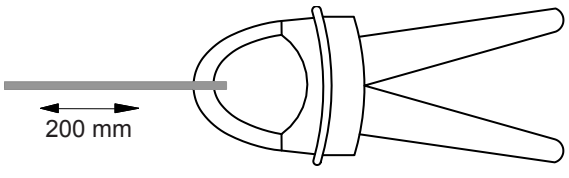
Three samples of the current sensor in NORMAL CONDITION and three samples of the current sensor that have been conditioned as specified in 10.5.2 a) are treated as follows.

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.



IEC 1866/12

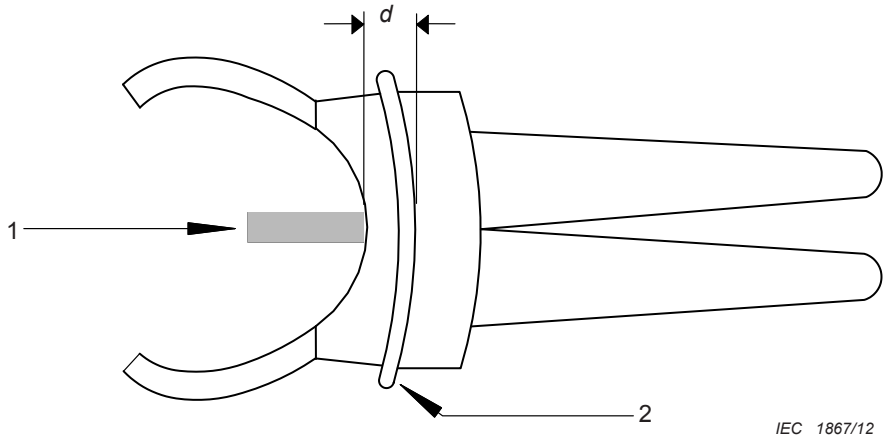
Figure 102 – Pre-treatment of the JAW ENDS

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:

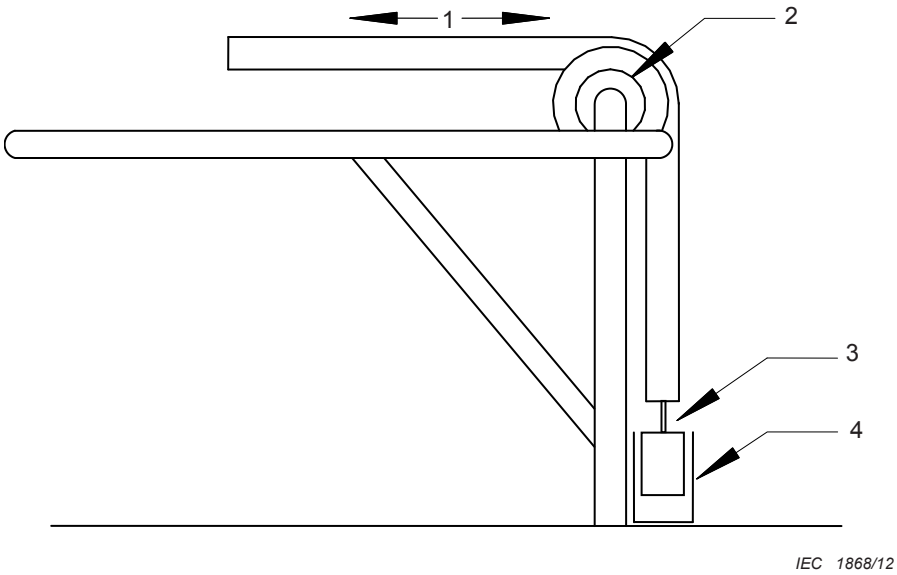
Three unconditioned samples of the flexible cord used for the JAW of the flexible current sensor and three samples conditioned as specified in 10.5.2 a) are tested. Each sample is 1 m long.

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.

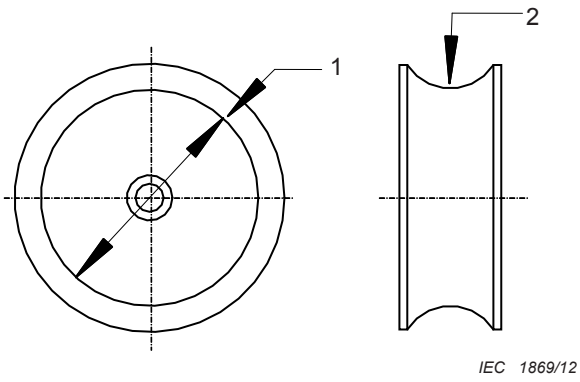
After this treatment, each sample is checked as specified by K.101.4. The voltage is applied between the internal conductors of the flexible cord and metal foil wrapped around the outer cord jacket. The BASIC INSULATION test voltage values are used if the cycling treatment was terminated because the 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	50
100	75
≥ 500	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.

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.

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

Addition:

Add the following new subclause:

10.5.101 Resistance to heat of current sensors

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 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.

Addition:

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) 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

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:

Addition:

Add the following new subclause:

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

If TRANSIENT OVERVOLTAGE are limited in a measuring circuit used to measure MAINS, the overvoltage limiting device 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 between each pair of TERMINALS used to measure MAINS where voltage-limiting devices are present.

NOTE 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. 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		
	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

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.

Addition:

Add the following new Clauses 101 and 102:

101 Measuring circuits

101.1 General

The equipment 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 any other compatible TERMINAL, with the range and function settings set in any possible manner (see 101.3).

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

d) A TEMPORARY OVERVOLTAGE or a TRANSIENT OVERVOLTAGE applied on the measuring circuits TERMINALS in 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, 101.2, 101.3, 101.4, Clause 16 and Clause 17 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 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 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.

The equipment 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 an uncertified current limitation device, an impedance, or a combination of both to prevent the HAZARD from arising. In this case, the tests of 101.3.3 apply.

Conformity is checked by inspection, evaluation of the design of the equipment, 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 all of the following requirements.

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.

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 voltage 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.

The possible a.c. short-circuit current need not exceed the applicable value of Table AA.1.

Additionally, spacings surrounding the overcurrent protection device in the equipment 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 RATINGS 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 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 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 during the REASONABLY FORESEEABLE MISUSE event;
2) if a resistor, be RATED for twice the power or energy dissipation that may result from the REASONABLY FORESEEABLE MISUSE event;
3) meet the applicable CLEARANCE and CREEPAGE DISTANCE requirements of Annex K for REINFORCED INSULATION between its terminations.

b) A combination of components which shall
1) withstand the maximum voltage that may be present during the REASONABLY FORESEEABLE MISUSE event;
2) be able to dissipate the power or energy that may result from the REASONABLY FORESEEABLE MISUSE event;
3) meet the applicable CLEARANCE and CREEPAGE DISTANCE requirements of Annex K for REINFORCED 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 three times on the same unit of equipment. If the test results in heating of any component, the equipment 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. The possible a.c. short-circuit current should not exceed the value 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. During and after the test, no HAZARD shall arise, nor shall there be any evidence of fire, arcing, explosion, or damage to impedance limitation devices 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 test leads that are included with the equipment and shall be repeated with test leads that meet the following specifications:

a) length = 1 m;

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

NOTE 1 A conductor with 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 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, 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).

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

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.

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 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 in 102.2 and 102.3 are done after the pre-treatment of the JAW ENDS specified in 6.9.101.1, if applicable.

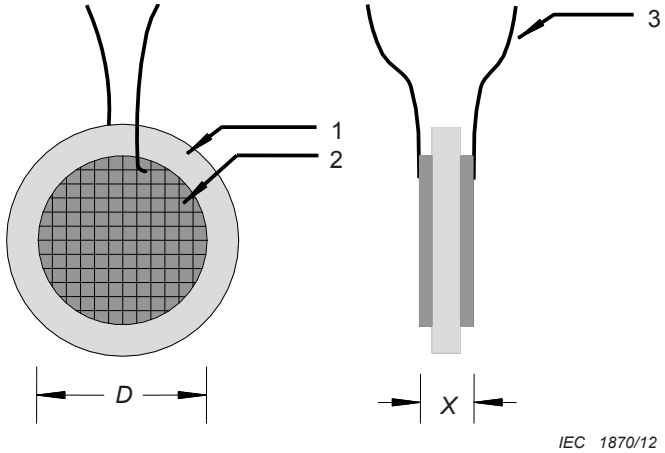
102.2 Protection against short-circuits during clamping

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 busbars.

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

For the purpose of this standard, 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 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 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 Table 105 for the considered voltage is inserted into the JAW opening as shown in Figure 107. If, for example, the RATED voltage of the JAWS is 450 V, then the tests will be 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

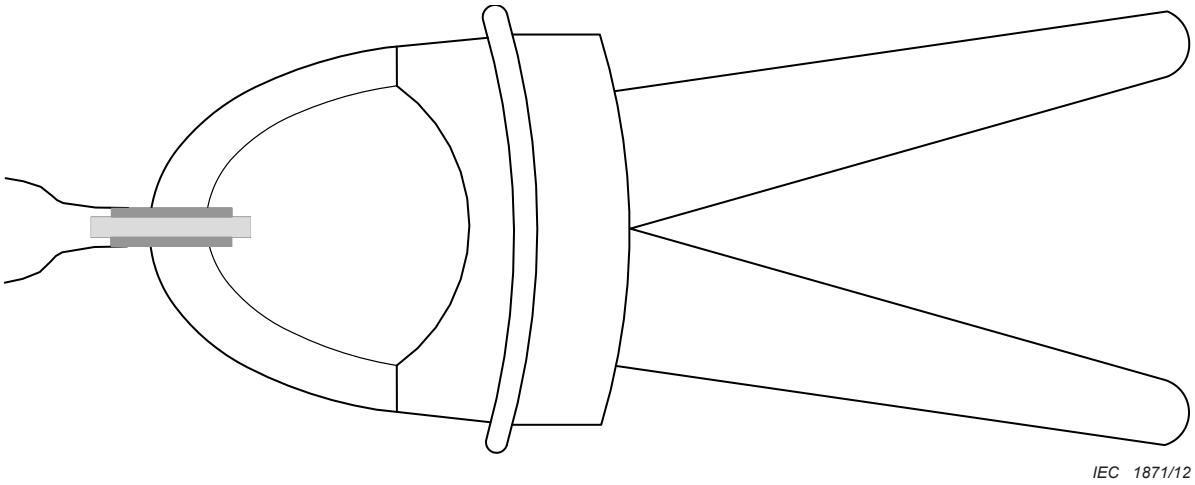


Figure 107 – Use of the test probe of Figure 106

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
> 150 ≤ 300	10	650	900
> 300 ≤ 600	15	1 300	1 850
> 600 ≤ 1 000	25	2 200	3 100

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

[b] The values for 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.

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.

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)

Replacement:

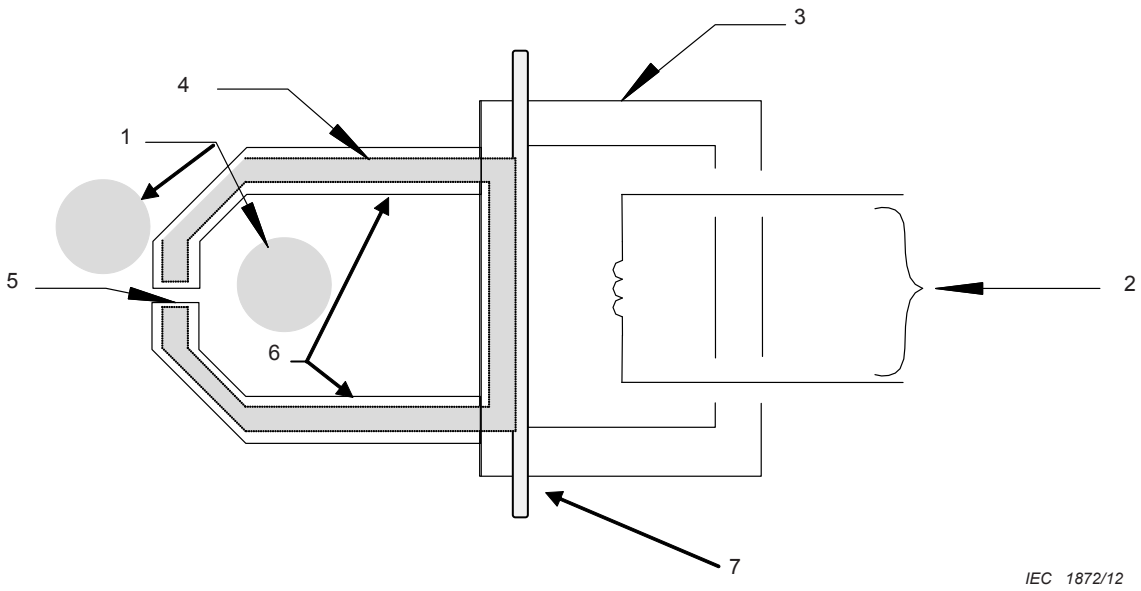
Replace the title of Annex D with the following title:

Annex D
(normative)

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

Addition:

Add the following new figure:



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)

Addition:

Add the following new table:

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

Current sensor	Insulation between							
	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	-	-

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] 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

Replacement:

Replace the first sentence with the following text:

The manufacturer shall perform the tests of F.2 to F.4 and F.101 on 100 % of equipment produced which has both HAZARDOUS LIVE parts and ACCESSIBLE conductive parts.

Addition:

Add the following new subclause:

F.101 JAWS of current sensors

For Type A, Type B, and Type C current sensors, a test voltage 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., d.c., or impulse, and is selected from Table F.101 for the appropriate MEASUREMENT CATEGORY. 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 series, conducted for a minimum of three pulses of each polarity at 1 s minimum intervals. For current sensors with no RATED 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

Replacement:

Replace the title of K.3 with the following:

K.3 Insulation for circuits not addressed in 6.7, 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:

Add the following new subclause:

K.101 Insulation requirements for measuring circuits of 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 be considered by the OPERATOR to ensure that they do not exceed the capabilities of the measuring equipment.

When the measuring circuit is used to connect to MAINS, there is a RISK of arc flash explosion. 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 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 in 5.1.5.2, 5.1.5.101 and 5.1.5.102.

CLEARANCES for measuring circuits of 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 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 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 K.3.

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

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	0,3	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

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, using the applicable test voltage of Table K.16 for the required CLEARANCE.

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

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.

The manufacturer should take the expected life of the equipment 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 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;

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

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 – Test voltages for testing electric strength of solid insulation in measuring circuits of MEASUREMENT CATEGORY II

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

Table K.103 – Test voltages for testing electric strength of solid insulation in measuring circuits of MEASUREMENT CATEGORY III

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

Table K.104 – Test voltages for testing electric strength of solid insulation in measuring circuits of MEASUREMENT CATEGORY IV

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

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

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

– for solid insulation used as an ENCLOSURE or PROTECTIVE BARRIER, the requirements of Clause 8;
– for moulded parts and potted parts, the requirements of K.101.4.2;
– for inner layers of printed wiring boards, the requirements of K.101.4.3;
– 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 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.

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

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.

   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, 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, 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.

   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, 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.

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

Annex L
(informative)

Index of defined terms

Addition:

Add the following defined terms:

Addition:

Add the following new Annexes AA and BB:

Annex AA
(normative)

MEASUREMENT CATEGORIES

AA.1 General

For the purpose of this standard, the following MEASUREMENT CATEGORIES are used. These MEASUREMENT CATEGORIES are not the same as the OVERVOLTAGE CATEGORIES according to Annex K of Part 1 and IEC 60664-1, or the impulse withstand categories (overvoltage categories) according to 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.

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).

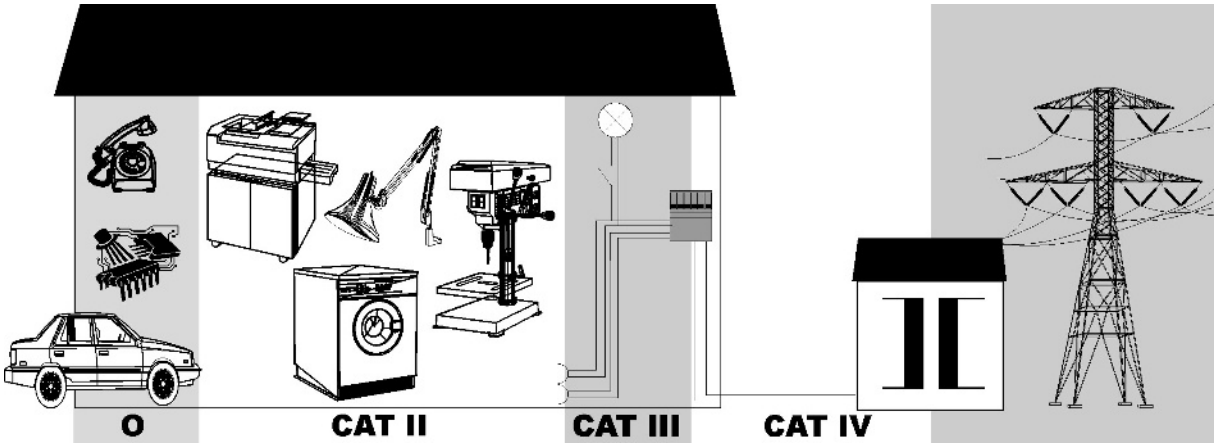
Due to these high short-circuit currents which can be followed by a high energy level, measurements made within these locations are extremely dangerous. Great precautions shall be made to avoid any chance of a short circuit.

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.



IEC 1873/12

Key

O	Other circuits that are not directly connected to MAINS
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

This annex 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

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.

When the measuring circuit is used to measure live MAINS, there is a RISK of arc flash explosion. 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.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 assure that the design requirements of this Part 2 and other related documents (for example, IEC 61010-031 for voltage probe assemblies) are met.

BB.2.3 Arc flash

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. 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 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.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 telecommunication 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 contact the proper 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 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.

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 MULTIMETERS and other METERS for domestic and professional use capable of measuring MAINS voltage*

EN 41003:1999, *Particular safety requirements for equipment to be connected to telecommunications networks*

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