UL 61010-2-032

STANDARD FOR SAFETY

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

UL Standard for 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, UL 61010-2-032

Third Edition, Dated October 17, 2024

Summary of Topics

This new Third Edition of ANSI/UL 61010-2-032 dated October 17, 2024 is an Adoption of IEC 61010-2-032, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2-032: Particular Requirements for Hand-Held and Hand-Manipulated Current Sensors for Electrical Test and Measurement (fifth edition, issued by IEC September 2023) as a new IEC-based UL standard with US National Differences.

The requirements are substantially in accordance with Proposal(s) on this subject dated August 2, 2024.

No Text on This Page

UL 61010-2-032

Standard for 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

First Edition – August, 2014
Second Edition – January, 2020

Third Edition

October 17, 2024

This ANSI/UL Standard for Safety consists of the Third Edition.

The most recent designation of ANSI/UL 61010-2-032 as an American National Standard (ANSI) occurred on October 17, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

No Text on This Page

CONTENTS

No Text on This Page

PREFACE (UL)

This UL Standard is based on IEC Publication 61010-2-032: fifth edition 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 publication 61010-2-032 is copyrighted by the IEC.

This edition has been issued to satisfy ULSE Standards policy.

This UL Standard 61010-2-032 Standard for 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, is to be used in conjunction with the lastest edition of UL 61010-1. The requirements for measurement equipment for insulation resistance and test equipment for electric strength are contained in this Part 2 Standard and UL 61010-1.

Requirements of this Part 2 Standard, where stated, amend the requirements of UL 61010-1.

Where a particular subclause of UL 61010-1 is not mentioned in UL 61010-2-032, the UL 61010-1 subclause applies.

Note - Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

No Text on This Page

NATIONAL DIFFERENCES

National Differences from the text of International Electrotechnical Commission (IEC) Publication 61010-2-032, Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-032: Particular requirements for hand-held and hand-manipulated current sensors for electrical test and measurement, copyright 2023 are indicated by notations (differences) and are presented in bold text.

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are National Differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

DR – These are National Differences based on the **national regulatory requirements**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.

Modification / Modify - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

No Text on This Page

FOREWORD

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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

This fifth edition cancels and replaces the fourth edition published in 2019. This edition constitutes a technical revision.

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

a) In 1.1.1, definitions of current sensor types have been moved to a new Annex FF;

b) Clause 2, all normative references have been dated and new normative references have been added;

c) 3.2.103, a new definition PROTECTIVE FINGERGUARD has been added which replaces the previous definition of PROTECTIVE BARRIER;

d) 4.4.2.101 is a new subclause about surge protective devices;

e) in 5.1.5.101.2, minimum RATINGS for voltage of measuring TERMINALS are required;

f) Subclause 6.5.1 has been modified;

g) Subclause 6.5.5 is no longer used;

h) Subclause 6.6.101 modifies 6.6.101 and 6.6.102 of previous edition:

1) in 6.6.101.1, insulating material of group I may be allowed for determination of CREEPAGE DISTANCES of measuring circuit TERMINALS;

2) in 6.6.101.2, CLEARANCES and CREEPAGE DISTANCES up to 3 000 V for measuring circuit TERMINALS in unmated position have been defined;

3) in 6.6.101.3, requirements for measuring circuit TERMINALS in partially mated position have been specified;

4) in 6.6.101.4, requirements for measuring circuit TERMINALS in mated position have been specified;

5) Subclause 6.6.101.5 replaces 6.6.102;

i) Subclause 6.6.102 replaces 6.101 of previous edition with modifications;

j) Subclause 6.101.2 replaces 6.9.101.1 of previous edition with modifications;

k) Subclause 6.101.3 replaces 6.9.101.2 of previous edition with modifications;

l) Subclause 6.101.4 replaces 6.9.102 of previous edition with modifications;

m) in 8.101, JAW ENDS abrasion test has been modified;

n) 8.105 is a new subclause for input/output leads attachment has been added;

o) in 9.101.2, relocation of 101.3 of previous edition;

p) in 9.101.3, relocation of 101.4 of previous edition, extension to MEASUREMENT CATEGORY II and reference to IEC 61000-4-5 for tests;

q) Table 104 has been replaced by Table K.101;

r) in 9.102, relocation of Clause 102 of previous edition;

s) in 14.101, relocation of 14.102. Subclause 14.101 of previous edition has been deleted;

t) 101.3 is a new subclause for protections against HAZARD occurring from reading a voltage value in replacement of Clause EE.5 of previous edition;

u) in Table D.101, transients are disregarded for insulation between JAW ENDS and input/output circuits;

v) in Clause F.101, test voltages for routine test of JAWS have been modified;

w) in K.2.1, another method for determination of CLEARANCES of secondary circuits is proposed;

x) in K.3.2, new Table K.15 and Table K.16 for CLEARANCE calculation;

y) K.3.101 is a new clause;

z) Clause K.4, redraft of the clause to propose a method for determination of U_t for circuits which reduce TRANSIENT OVERVOLTAGES;

aa) Table K.101 replaces Table 104;

bb) Subclause K.101.4 has been reviewed and tables and tests for solid insulation have been modified;

cc) Table K.104 of previous edition has been deleted;

dd) Annex AA: Figure AA.1 has been redesigned;

ee) Annex EE: addition of a new informative annex for determination of CLEARANCES for Table 101;

ff) Annex GG: this annex was Annex EE of previous edition and the current sensor type of a CLAMP MULTIMETER is type A or type B.

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

Draft	Report on voting
66/788A/FDIS	66/798/RVD

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

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

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

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 document is to be used in conjunction with IEC 61010-1:2010 and IEC 61010-1:2010/AMD1:2016.

This document 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 IEC 61010-1 is not mentioned in this document, that subclause applies as far as is reasonable. Where this document states "addition", "modification", "replacement", or "deletion", the relevant requirement, test specification or note in IEC 61010-1 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 IEC 61010-1 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 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 document 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.

101DV DE *Modification to add the following to IEC Foreword:*

The numbering system in the standard uses a space instead of a comma to indicate thousands and uses a comma instead of a period to indicate a decimal point. For example, 1 000 means 1,000 and 1,01 means 1.01.

102DV DE *Modification to add the following to the IEC Foreword:*

For this Standard, all references to “IEC 61010-1:2010” or “IEC 61010 1:2010/AMD1:2016” refer to UL 61010-1.

For this Standard, all references to IEC 61010-2-030, IEC 61010-2-033 and IEC 61010-2-034 refer to UL versions of the particulars.

For this Standard, all references to IEC 61010-031 refer to UL 61010-031.

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 and its amendment will be supplemented or modified by the special requirements of one or more standard from the IEC 61010-2 series which is/are read in conjunction with the requirements of IEC 61010-1.

1) IEC 61010-2-030:2023 specifies the safety requirements for equipment with testing or measuring circuits which are connected for test or measurement purposes to devices or circuits outside the measurement equipment itself.

2) This document specifies the safety requirements for hand-held and hand-manipulated current sensors for measuring, detecting or injecting current, or indicating current waveforms on circuits without physically opening the current path of the circuit being measured.

Most of the requirements of IEC 61010-2-030:2023 have been included in this document. Equipment within the scopes of both IEC 61010-2-030:2023 and this document is considered to be covered by the requirements of this document.

However, for current sensors in combined equipment with protective bonding and automatic disconnection of the supply, IEC 61010-2-030:2023 and this document are read in conjunction.

3) IEC 61010-2-033:2023 specifies the safety requirements for hand-held multimeters and other meters for domestic and professional use, capable of measuring mains voltage, intended to measure voltage and other electrical quantities such as resistance or current.

All relevant requirements of IEC 61010-2-030 have been included in IEC 61010-2-033:2023.

4) IEC 61010-2-034:2023 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.

All relevant requirements of IEC 61010-2-030:2023 have been included in IEC 61010-2-034:2023. However, for equipment within the scope of this document and IEC 61010-2-034:2023, these standards are read in conjunction.

IEC 61010-031 specifies the safety requirements for hand-held and hand-manipulated probe assemblies and their related accessories intended to be used in particular with equipment in the scope of IEC 61010-2-030, this document, IEC 61010-2-033 and IEC 61010-2-034. These probe assemblies are for non-contact or direct electrical connection between a part and electrical test and measurement equipment. They may be fixed to the equipment or be detachable accessories for the equipment.

No Text on This Page

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

IEC 61010-1:2010, Clause 1 and IEC 61010-1:2010/AMD1:2016, Clause 1 apply except as follows:

1.1.1 Equipment included in scope

Replace the existing text with the following:

This document specifies safety requirements for HAND-HELD and hand-manipulated current sensors intended for measuring, detecting or injecting current, or indicating current waveforms on circuits without physically opening the current path of the circuit being measured.

These current sensors are hand-manipulated before and/or after a test or measurement, but are not necessarily HAND-HELD during the test or measurement. They can be stand-alone current sensors or accessories to other equipment or parts of combined equipment. These include measurement circuits which are part of electrical test and measurement equipment, laboratory equipment, or process control equipment.

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.

The types of current sensors covered by this document are defined in Annex FF.

1.1.2 Equipment excluded from scope

Add the following new paragraph:

This document does not apply to current sensors used as FIXED EQUIPMENT.

1.2.1 Aspects included in scope

Replace item c) of the second paragraph with the following new item c):

c) spread of fire or arc flash from the current sensor (see Clause 9);

Replace the third paragraph with the following two new paragraphs:

Requirements for protection against HAZARDS arising from NORMAL USE, REASONABLY FORESEEABLE MISUSE and ergonomic factors are specified in Clause 16, Clause 101 and Annex GG.

Annex BB provides guidance to equipment manufacturers on HAZARDS that should be considered for equipment intended for performing tests and measurements on hazardous conductors, including MAINS conductors and telecommunication network conductors.

2 Normative references

IEC 61010-1:2010, Clause 2 and IEC 61010-1:2010/AMD1:2016, Clause 2 apply except as follows:

Replace the following existing normative references:

IEC 60068-2-75, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*
IEC 60364-4-44:2007/AMD1:2015

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

IEC 61180 (all parts), *High-voltage test techniques for low-voltage equipment*

IEC 61180-1, *High-voltage test techniques for low-voltage equipment – Part 1: Definitions, test and procedure requirements*

IEC 61180-2, *High-voltage test techniques for low-voltage equipment – Part 2: Test equipment*

IEC 62262, *Degrees of protection provided by enclosures for electrical equipment against external impacts (IK code)*

with the following new normative references:

IEC 60068-2-75:2014, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*
IEC 60364-4-44:2007/AMD1:2015
IEC 60364-4-44:2007/AMD2:2018

IEC 61010-031:2022, *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 61180:2016, *High-voltage test techniques for low-voltage equipment – Definitions, test and procedure requirements, test equipment*[1]

[1] "IEC 61180:2016" replaces everywhere IEC 61180, IEC 61180-1 and IEC 61180-2 are referenced in IEC 61010-1.

IEC 62262:2002, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*
IEC 62262:2002/AMD1:2021

Add the following new normative reference:

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*
IEC 61000-4-5:2014/AMD1:2017

2DV DR *Modification: Add the following*

The requirements of this UL Standard shall take precedence over the International Standard on which it is based; any reference within this standard to the International Standard shall be replaced by a reference to the equivalent US Standard.

3 Terms and definitions

IEC 61010-1:2010, Clause 3 and IEC 61010-1:2010/AMD1:2016, Clause 3 apply 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 three 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

3.2.103
PROTECTIVE FINGERGUARD
part of the enclosure that indicates the limit of safe access and that reduces the risk of the operator touching HAZARDOUS LIVE parts

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

3.6 Insulation

Add the following new term and definition:

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

4 Tests

IEC 61010-1:2010, Clause 4 and IEC 61010-1:2010/AMD1:2016, Clause 4 apply except as follows:

4.3.2.5 MAINS supply

Replace the existing title and text with the following:

4.3.2.5 Power supply

The following requirements apply:

a) the voltage of the power supply connected to the MAINS shall be between 90 % and 110 % of any RATED supply voltage for which the current sensor can be set or, if the current sensor is RATED for a greater fluctuation, at any supply voltage within the fluctuation range;

b) the MAINS frequency shall be any RATED frequency;

c) current sensors for both a.c. and d.c. shall be connected to an a.c. or d.c. supply;

d) current sensors powered from MAINS by single-phase a.c. shall be connected both with normal and reverse polarity;

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

4.3.2.6 Input and output voltages

Replace the existing title and text with the following:

4.3.2.6 Input and output voltages or currents

Input and output voltages or currents, including floating voltages but excluding the supply voltage connected to the MAINS, 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.

Add the following new subclause:

4.4.2.101 Surge protective devices

Surge protective devices used in MAINS CIRCUITS or in circuits measuring MAINS shall be short-circuited and open-circuited.

5 Marking and documentation

IEC 61010-1:2010, Clause 5 and IEC 61010-1:2010/AMD1:2016, Clause 5 apply except as follows:

5.1.2 Identification

Add the following new list items and add a new paragraph before the conformity statement:

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;

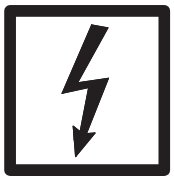
cc) for Type B and Type C current sensors, with symbol 101 of Table 1;

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 adjacent to the marking of the MEASUREMENT CATEGORY for the JAWS, if present (see 5.1.5.101 and 5.1.5.102).

Add the following two new symbols:

Table 1
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)	To indicate that the current sensor can safely be used with UNINSULATED HAZARDOUS LIVE CONDUCTORS

5.1.5 TERMINALS, connections and operating devices

Add the following new subclause:

5.1.5.101 Measuring circuit TERMINALS

5.1.5.101.1 General

Some measuring circuit TERMINALS for the current sensor within the scope of this document also serve as output TERMINALS.

Except as permitted in 5.1.5.101.4:

a) the value of the nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured shall be marked for measuring circuit TERMINALS RATED for MEASUREMENT CATEGORIES, or the value of the RATED voltage to earth for other measuring circuit TERMINALS, and

NOTE CLEARANCES and solid insulation for MEASUREMENT CATEGORIES are specified for a nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured. Neutral is considered to be earthed (see Annex I).

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.

Symbol 14 of Table 1 shall be marked if current measuring TERMINALS are not intended for connection to current transformers without internal protection (see 101.2).

Markings shall be placed adjacent to the TERMINALS. However, if there is insufficient space (as in multi-input current sensor), 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.

The RATED voltage of the TERMINALS of a measuring circuit intended for MAINS voltage measurements shall be equal to or higher than their RATED a.c. r.m.s. line-to-neutral or d.c. voltage.

Marking those TERMINALS with more than one type of MEASUREMENT CATEGORY and its RATED voltage 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 adjacent to the TERMINALS 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 5.4.1 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

It is not necessary to mark measuring circuit TERMINALS 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 does not exceed the levels of 6.3.1.

NOTE Examples of acceptable indications that the RATED voltage of the inputs are intended to not exceed the levels of 6.3.1 include:

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

– 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, does not exceed 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 nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured when JAWS are RATED for MEASUREMENT CATEGORIES, otherwise 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 a.c. r.m.s. line-to-neutral or d.c. voltage marking (see also note of 5.1.5.101.1). 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 two new items to the list and a new paragraph at the end of the list:

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).

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.

5.4.3 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 FINGERGUARD, 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

IEC 61010-1:2010, Clause 6 and IEC 61010-1:2010/AMD1:2016, Clause 6 apply 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 6.101.

6.5.1 General

Replace the text, the conformity statement, and Figure 4 with the following text, conformity statement and Figure 4:

ACCESSIBLE parts shall be prevented from becoming HAZARDOUS LIVE in SINGLE FAULT CONDITION. The primary means of protection (see 6.4) shall be supplemented by one of a) or b) below. Alternatively, one of the single means of protection c) or d) below shall be used (see Figure 4 and Annex DD).

a) SUPPLEMENTARY INSULATION (see 6.5.3);

b) current- or voltage-limiting device (see 6.5.6);

c) REINFORCED INSULATION (see 6.5.3);

d) PROTECTIVE IMPEDANCE (see 6.5.4).

Conformity is checked by inspection and as specified in 6.5.3, 6.5.4, or 6.5.6, as applicable.

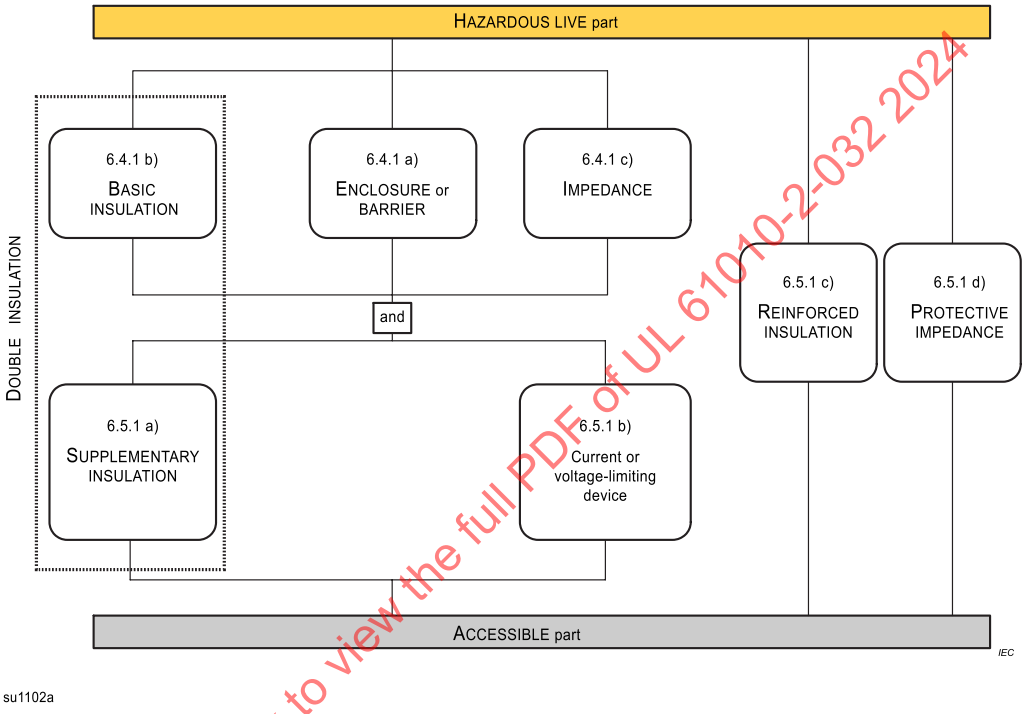


Figure 4

Acceptable arrangement of protective means against electric shock

6.5.2 PROTECTIVE BONDING

Replace the existing title of 6.5.2 with the following title and delete the text:

6.5.2 Not used

6.5.5 Automatic disconnection of the supply

Replace the existing title of 6.5.5 with the following title and delete the text:

6.5.5 Not used

6.6 Connections to external circuits

Add the following two new subclauses and table:

6.6.101 Measuring circuit TERMINALS

6.6.101.1 General

When determining the values of CREEPAGE DISTANCES for measuring circuit TERMINALS of a HAND-HELD current sensor intended to be connected only to a HAND-HELD probe assembly complying with IEC 61010-031:2022, the applicable values of CREEPAGE DISTANCES from material group I are allowed to be applied to all material groups.

Requirements for measuring circuit TERMINALS in unmated position, partially mated or mated position are defined respectively in 6.6.101.2, 6.6.101.3 and 6.6.101.4. Requirements for specialized measuring circuit TERMINALS are defined in 6.6.101.5.

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

6.6.101.2 Measuring circuit TERMINALS in unmated position

The following requirements apply to measuring circuits TERMINALS in unmated position when RATED voltages are applied to any other TERMINALS of the current sensor.

1) ACCESSIBLE parts of locking-type or screw-held-type TERMINALS in unmated position including TERMINALS which do not require the use of a TOOL for unlocking or unscrewing shall not be HAZARDOUS LIVE.

Conformity is checked by inspection.

2) ACCESSIBLE parts of other unmated measuring circuit TERMINALS shall be insulated from HAZARDOUS LIVE parts by PROTECTIVE IMPEDANCE or CLEARANCES and CREEPAGE DISTANCES meeting the requirements of 2 a) and 2 b).

a) For measuring circuit TERMINALS with a voltage RATING up to 3 000 V, the CLEARANCES shall be at least the applicable values of Table 101.

Table 101
CLEARANCES for unmated measuring circuit TERMINALS

Maximum voltage applied to the conductive parts of the TERMINAL	CLEARANCE	
	a.c. r.m.s.	d.c.
V	mm	mm
600	0,8	0,8
1 000	1,0	0,8
1 500	2,0	1,1
2 000	3,2	1,8
3 000	6,4	3,5
For maximum voltages above 30 V a.c. r.m.s. or 60 V d.c. up to 600 V, CLEARANCES are 0,8 mm. Linear interpolation is allowed above 600 V. NOTE See Annex EE.		

For measuring circuit TERMINALS with a voltage RATING above 3 000 V, the CLEARANCE shall be at least the D_2 value of Table K.15 with U_m equal to 1,25 times the peak value of the voltage (see K.3.2).

If the current sensor is RATED to operate at an altitude greater than 2 000 m, the value of the CLEARANCE shall be multiplied by the applicable factor of Table 3.

Conformity is checked by one of the following tests:

i) inspection and measurement of CLEARANCE from the closest approach of the test finger touching the external parts of the TERMINAL in the least favourable position (see Figure 1), or

ii) the a.c. voltage test of 6.8.3.1 or the d.c. voltage test of 6.8.3.2 for TERMINAL stressed only by d.c. 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.15 for the required CLEARANCE.

Correction factors of Table 10 are applicable to the values of test voltages for CLEARANCES given in Table K.15.

b) The CREEPAGE DISTANCE values shall be at least the applicable CLEARANCE values defined in 2 a) of this Subclause 6.6.101.2.

Conformity is checked by inspection and measurement of CREEPAGE DISTANCES from the closest approach of the test finger touching the external parts of TERMINAL in the least favourable position.

In addition for current sensors RATED for WET LOCATIONS, conductive parts of TERMINALS with voltage RATINGS above 16 V a.c. r.m.s., 22,6 V a.c. peak and 35 V d.c. shall not be ACCESSIBLE.

Conformity is checked by inspection and measurement.

6.6.101.3 Measuring circuit TERMINALS in partially mated position

ACCESSIBLE parts of measuring circuit TERMINALS in partially mated position shall be insulated from HAZARDOUS LIVE parts by BASIC INSULATION.

Conformity is checked by inspection and measurement.

6.6.101.4 Measuring circuit TERMINALS in mated position

ACCESSIBLE parts of measuring circuit TERMINALS in mated position which are not intended to be HAND-HELD or touched during the measurement operation shall be insulated from HAZARDOUS LIVE parts by BASIC INSULATION.

ACCESSIBLE parts of TERMINALS of other measuring circuits in mated position shall be insulated from HAZARDOUS LIVE parts by DOUBLE INSULATION or REINFORCED INSULATION.

Conformity is checked by inspection and measurement.

6.6.101.5 Specialized measuring circuit TERMINALS

Specialized measuring circuit TERMINALS are TERMINALS intended to be connected to components, sensors, and devices.

NOTE These specialized TERMINALS include, but are not limited to, TERMINALS for thermocouple sockets.

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.

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 of the other measuring circuit TERMINALS, 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.

6.6.102 Input/output circuit leads

6.6.102.1 General

Input/output circuit leads are used to connect the current sensor to external equipment for the purpose of measuring the current on the secondary circuit or powering the current sensor.

Input/output circuit leads shall meet the requirements of 6.6.102.2 and 6.6.102.3, and attachment of the output circuit leads shall meet the requirements of 8.105 (see also Table D.101, column with heading "2 and 3").

6.6.102.2 Protection against HAZARDOUS LIVE installation

When current sensors are connected by a cord or a test lead to a measuring instrument and/or an external power supply, the outer surfaces of the input/output circuit leads can easily touch HAZARDOUS LIVE parts of the installation under test.

The input/output circuit leads and the mated TERMINALS which can be in contact with parts of the installation 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 input/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 input/output circuit but not less than 300 V in MEASUREMENT CATEGORY II.

For Type D current sensors, the insulation of the input/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 value or the voltage test of K.101.2 for CLEARANCES, by measurement of the applicable value of K.101.3 for CREEPAGE DISTANCES, and by the voltage tests of K.101.4.1 a) and b) for solid insulation.

6.6.102.3 Protection against rise of potential from measuring or control equipment

When connected to measuring or control equipment (wattmeter, power quality analyser, etc.), the inner conductors of input/output circuit leads of current sensors can be held at a HAZARDOUS LIVE voltage, when the internal ground of the measuring or control equipment is at the potential of a HAZARDOUS LIVE conductor.

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 9.101.2.

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 9.101.2, by inspection and,

a) if the current sensor is RATED for MEASUREMENT CATEGORIES, by measurement of the applicable value or the voltage test of K.101.2 for CLEARANCES, by measurement of the applicable value of K.101.3 for CREEPAGE DISTANCES, and by the voltage tests of K.101.4.1 a) and b) for solid insulation;

b) if the current sensor is not RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values of K.3.2, K.3.3 or K.3.101 for CLEARANCES and of K.3.4 for CREEPAGE DISTANCES, and by the voltage tests of K.3.5 for solid insulation.

6.7.1.3 Creepage distances

Add the following new paragraph after the third paragraph:

For current sensors not powered from the MAINS or from the measuring circuit, the applicable values of CREEPAGE DISTANCES from material group I are allowed to be applied to all materials.

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;

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

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) by means of a transformer only;

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 1 See Annex I for line-to-neutral voltage pertinent to MAINS type and nominal voltage.

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

NOTE 3 See Clause K.3 for requirements for switching circuits such as a switching power supply.

The TRANSIENT OVERVOLTAGE levels for the MAINS correspond to the impulse voltage values specified in Table K.101.

6.8.1 General

Replace the second and third paragraphs with the following three new paragraphs:

Test equipment for the voltage tests is specified in IEC 61180:2016.

For testing CLEARANCES of unmated TERMINALS (see 6.6.101.2 2) a) ii)), the reference point for application of the test voltage is determined using the test finger applied to the external parts of the TERMINAL in the least favourable position with the closest approach. Alternatively, a test probe with a tip in the shape of the test finger can be used for application of the test voltage.

For other testing, ACCESSIBLE insulating parts of the ENCLOSURE are covered with metal foil everywhere except around unmated TERMINALS. For test voltages up to 10 kV a.c. peak or 10 kV d.c., the distance from foil to TERMINAL is not more than 20 mm. For higher voltages it is the minimum to prevent flashover. For guidance on these minimum distances, see Table 9.

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 ±3 % of the specified value.

6.8.3.2 The d.c. voltage test

Add a new sentence at the beginning of the first paragraph:

The voltage tester shall have a regulated output capable of maintaining the test voltage throughout the test within ±3 % of the specified value.

Add the following new subclause:

6.101 Protection against HAZARDOUS LIVE conductors

6.101.1 General

Current sensors need additional protective means against HAZARDOUS LIVE conductors. They shall meet the requirements of the following subclauses when applicable, 6.101.2 (for Type A current sensors,

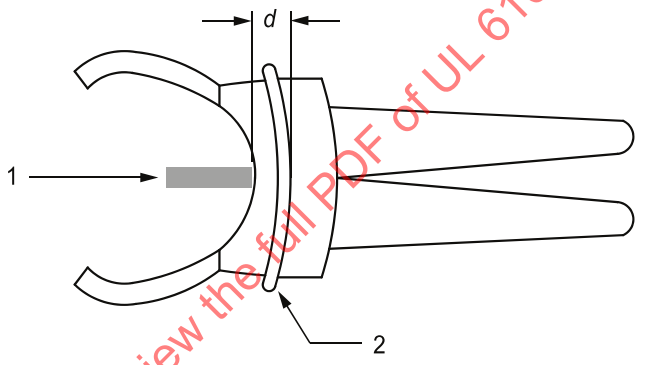
protection by a PROTECTIVE FINGERGUARD), 6.101.3 (for Type A current sensors, insulation of HAND-HELD or hand-manipulated parts) or 6.101.4 (for Type A, Type B and Type C current sensors, insulation of input/output circuits).

6.101.2 Protection by a PROTECTIVE FINGERGUARD

To reduce the RISK of the OPERATOR touching the HAZARDOUS LIVE conductor during clamping or measurement, Type A current sensors shall have a PROTECTIVE FINGERGUARD to warn the OPERATOR of the limit of safe access. The PROTECTIVE FINGERGUARD 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 FINGERGUARD shall meet the requirements for REINFORCED INSULATION for the RATING of the JAWS. Figure 101 gives an example of the CLEARANCE *d* from the PROTECTIVE FINGERGUARD 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 FINGERGUARD

d distance between PROTECTIVE FINGERGUARD and HAZARDOUS LIVE conductor

Figure 101

CLEARANCE between the PROTECTIVE FINGERGUARD to the JAWS and to the HAZARDOUS LIVE conductor

6.101.3 Insulation of HAND-HELD or hand-manipulated parts for Type A current sensors

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 (see Table D.101, column with heading "1 and 3").

If conductive parts of the magnetic circuit can touch a conductor, the magnetic circuit is considered to be held at the RATED voltage to earth of the JAWS (see Table D.101, column with heading "3 and 5").

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 or the voltage test of K.101.2 for CLEARANCES, by measurement of the applicable value of K.101.3 for CREEPAGE DISTANCES, and by the voltage tests of K.101.4.1 a) and b) for solid insulation;

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

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.

6.101.4 Insulation of 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 (see Table D.101, columns with heading "1 and 2" and heading "2 and 6"). 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 or the voltage test of K.101.2 for CLEARANCES, by measurement of the applicable value of K.101.3 for CREEPAGE DISTANCES, and by the voltage tests of K.101.4.1 a) and b) for solid insulation;

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

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.

7 Protection against mechanical HAZARDS

IEC 61010-1:2010, Clause 7 and IEC 61010-1:2010/AMD1:2016, Clause 7 apply.

8 Resistance to mechanical stresses

IEC 61010-1:2010, Clause 8 applies except as follows:

Add the following five new subclauses, three tables and five figures:

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 JAW ENDS abrasion test of this Subclause 8.101, 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. The requirements of this Subclause 8.101 do not apply to current sensors with a sliding JAW, current sensors with fork-style JAWS and flexible current sensors.

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 is 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 102 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 102). The emery cloth is replaced after each sample has been treated.

a) If the JAW ENDS include a wear indicator, the test has a minimum of 25 cycles. The test is terminated 2 cycles after the wear indicator becomes visible, but is not carried out for more than 50 cycles in total.

NOTE 25 cycles are performed if the wear indicator becomes visible before the 23rd cycle and 50 cycles are performed if the wear indicator is not visible before the 48th cycle.

b) If the JAW ENDS do not include a wear indicator, the test is terminated when 50 cycles are completed.

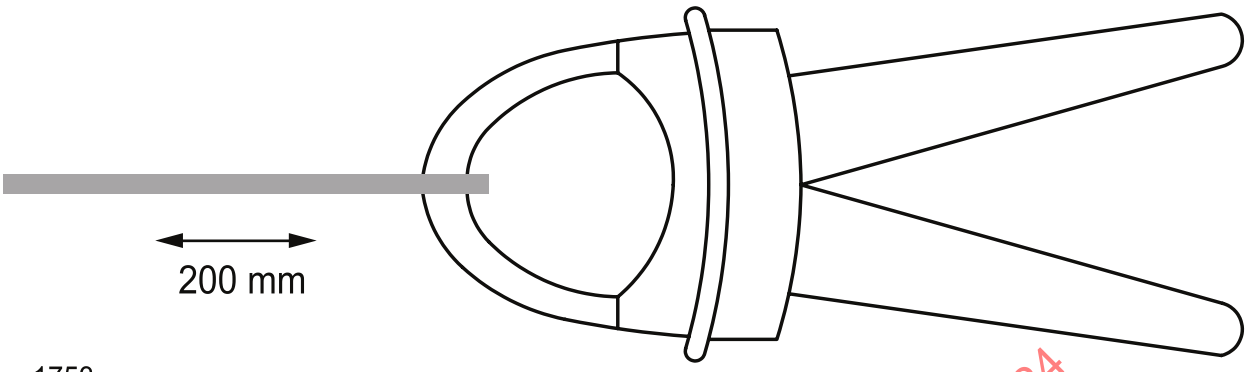


Figure 102

Abrasion test of the JAW ENDS

After the abrasion test, the samples of current sensor are submitted to the provisions of the conformity statements of 6.101.3 and 6.101.4.

8.102 JAW impact test

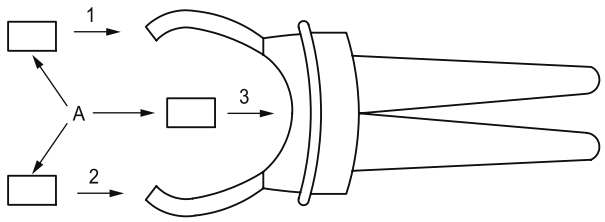
When current sensors are applied to or removed from conductors, they can hit them and be damaged, in particular when the conductor is a busbar. These current sensors shall be designed to be safe after the JAW impact test of this Subclause 8.102, performed to simulate the stress of the JAWS during insertion. 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 taken from Table 102.

The test is carried out on one sample of current sensor. The sample is tested according to IEC 60068-2-75:2014 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 103). The number of impacts is one per point.



su1754a IEC

Key

A hammer

1, 2, 3 direction of impact

Figure 103

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 provisions of the conformity statements of 6.101.3 and 6.101.4.

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 pressure test of this Subclause 8.103, 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:

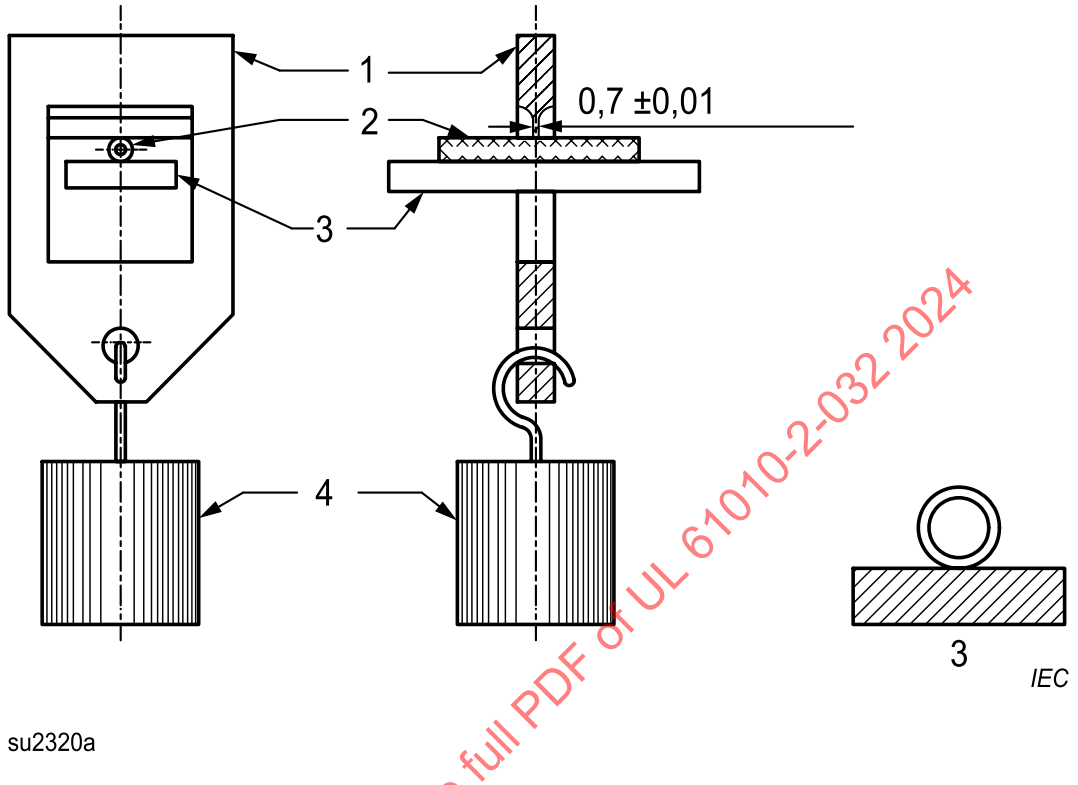
a) If they do not have a wear indicator, they shall provide at least DOUBLE INSULATION or REINFORCED INSULATION after typical lifetime wear.

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 104, 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 104. 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 104

Indentation device

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

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

where

F is the compressing force 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.

Values 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.101.4.1 a) and b) (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 by the JAWS of a 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 has not moved more than 1 mm above the displacement from the first pull if it is subjected to 16 pulls;

b) CLEARANCES and CREEPAGE DISTANCES have not 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 passes the applicable tests for REINFORCED INSULATION defined in K.101.4.1 a) and b) 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.

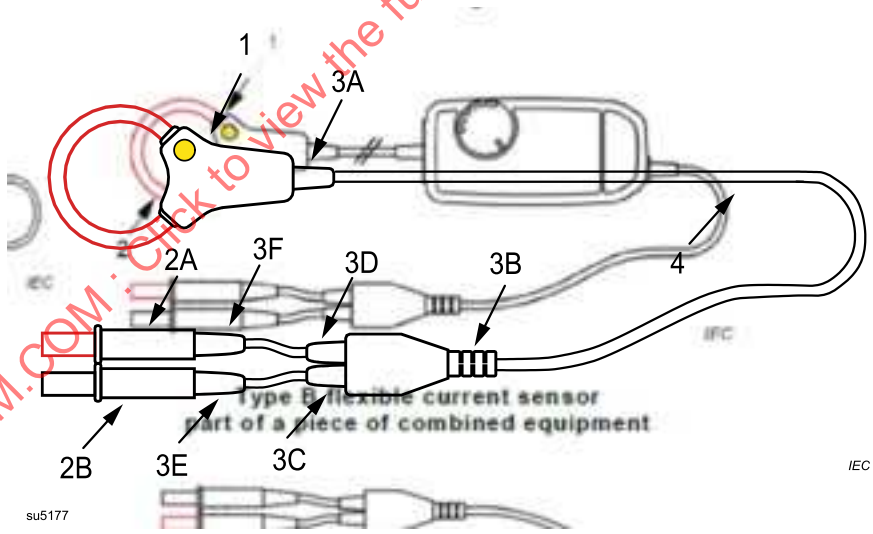
Table 103
Pull forces for endcaps of flexible current sensors

Maximum diameter of the flexible cord mm	Pull force N
5	50
10	75
20	100
Linear interpolation is allowed. For diameters up to 5 mm, pull force is 50 N and for diameters above 20 mm, pull force is 100 N.	

8.105 Attachment of the input/output leads

8.105.1 General

The attachment of the input/output leads to the current sensor and to the TERMINALS (see Figure 105) shall withstand forces likely to be encountered in NORMAL USE without damage which could cause a HAZARD. The insulation of the input/output leads shall be mechanically secured to avoid retraction.



Key

1 current sensor body
2A and 2B TERMINALS
3A to 3F strain reliefs
4 cord

Figure 105

Example of a current sensor with strain reliefs

Samples of current sensors are conditioned according to 8.105.2 or 8.105.3. Each strain relief (or point of attachment) of the input/output lead is subjected to only one of the three conditioning tests in a) to c) below before being checked.

NOTE For test purposes, it can be useful to prepare special samples, manufactured in all respects like the current sensor being investigated.

Conformity is checked after conditioning of the samples by the following inspection and tests:

a) the insulation of the input/output lead has not been cut or torn, and has not moved more than 2 mm in the bushings;

b) no more than 75 % of the copper strands of the input/output lead have been broken;

c) the provisions of conformity statements of 6.6.102.2 and 6.6.102.3 have been carried out, as applicable.

8.105.2 Pull test

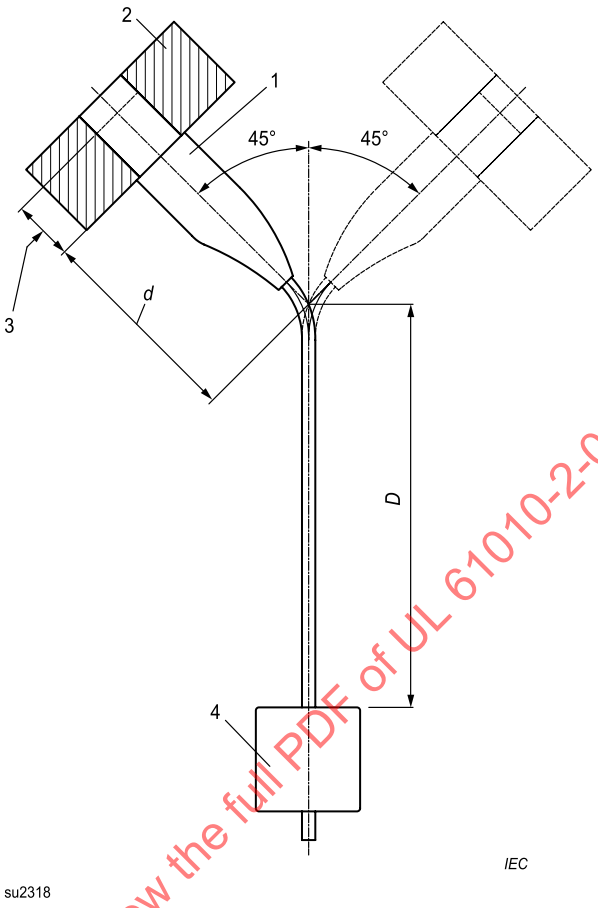
With the current sensor or connector clamped so that it cannot move, the input/output lead is subjected for 1 min to a steady axial pull twice the pull force value from Table 104.

8.105.3 Flexing test

Each strain relief (or point of attachment) of the input/output lead is subjected to a flexing test in an apparatus similar to that shown in Figure 106.

The current sensor or the TERMINAL is fixed to the oscillating member of the apparatus so that, when this is at the midpoint of its travel, the axis of the input/output lead, where it enters the current sensor or the TERMINAL, is vertical and passes through the axis of oscillation.

The oscillating member is, by variation of distance d shown in Figure 106, so positioned that the input/output lead makes a minimum lateral movement when the oscillating member of the test apparatus is moved over its full travel.



Key

D > 300 mm

1 strain relief of TERMINAL or current sensor body

2 part of oscillating member for fixing the TERMINAL or the current sensor body

3 depth specified for the shroud of corresponding equipment TERMINAL

4 weight

Figure 106

Flexing test

The input/output lead is loaded with a weight such that the force from Table 104 is applied.

The oscillating member is moved to each side of vertical through a total angle of 90° (45° on each side of vertical). The total number of flexings is 5 000. The rate of flexing is 60 per minute. A complete cycle is two flexings.

Current sensors or TERMINALS with input/output lead of nominally circular cross-sectional area are rotated approximately 90° around the vertical axis within the oscillating member after 2 500 flexings; current sensors or TERMINALS with flat flexible input/output lead are not so rotated, and are only flexed in a direction perpendicular to the thinner dimension of the cross-section.

If a HAZARD can result from the breaking of a conductor or a short-circuit between conductors, a current equal to the RATED current of the current sensor is passed through each conductor, the voltage between them being the RATED voltage. During the test, there shall be no interruption of the test current and no short-circuit between the conductors.

Table 104
Pull forces for input/output lead attachment test

Cross-sectional area of the conductor (*a*) mm^2	Pull force N
0,25	2,5
0,50	5
1,0	10
2,5	18
4	25
6	30
10	40
16	45
Linear interpolation is allowed. For input/output leads with multiple conductors, the cross-sectional area (*a*) is calculated as the sum of the cross-sectional areas of the individual conductors. For the purpose of this calculation, the cross-sectional area of any shield is ignored.	

9 Protection against the spread of fire

Replace the existing title with the following title:

9 Protection against the spread of fire and arc flash

IEC 61010-1:2010, Clause 9 and IEC 61010-1:2010/AMD1:2016, Clause 9 apply except as follows:

Add the following two new subclauses, two figures and table:

9.101 Protection of measuring circuits

9.101.1 General

The current sensor shall provide protection against fire or arc flash resulting from NORMAL USE and REASONABLY FORESEEABLE MISUSE of measuring circuits, as specified in a) and b) below:

a) an electrical quantity that is within specification for any TERMINAL 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 9.101.2);

b) a TEMPORARY OVERVOLTAGE or a TRANSIENT OVERVOLTAGE when it is applied on the measuring circuit TERMINALS in a voltage measurement function (see 9.101.3).

Conformity is checked as specified in 9.101.2 and 9.101.3 as applicable.

9.101.2 Protection against mismatches of inputs and ranges

9.101.2.1 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 assembly or of the 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 requirements of this Subclause 9.101.2.1.

The current sensor shall provide protection against these HAZARDS. One of the following techniques in a) or b) shall be used:

a) use of a certified overcurrent protection device to interrupt short-circuit currents before a HAZARD arises (see 9.101.2.2);

b) use of an uncertified current limitation device, an impedance, or a combination of both to prevent the HAZARD from arising (see 9.101.2.3).

Conformity is checked by inspection, evaluation of the design of the current sensor, and as specified in 9.101.2.2 and 9.101.2.3, as applicable.

9.101.2.2 Protection by a certified overcurrent protection device

An overcurrent protection device is considered suitable if it is certified by a recognized testing authority and if all of the following requirements in a) to c) 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 9.101.2.4 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.

9.101.2.3 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 event of REASONABLY FORESEEABLE MISUSE.

An impedance used for limitation of current shall be an appropriate single component as specified in a) or a combination of components as specified in b).

a) An appropriate single component which is constructed, selected, and tested so that safety and reliability for protection against relevant HAZARDS is ensured. 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 occur 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 occur 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.

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 9.101.2.4 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, except for fuses which can open.

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

9.101.2.3DV D2 *Modification of 9.101.2.3: Add the following paragraph:*

If the function or range controls have any effect on the electrical characteristics of the input circuit, the test shall be repeated with these controls being changed to all possible settings while the input TERMINALS are connected to the maximum RATED source.

9.101.2.4 Test leads for the tests

The tests of 9.101.2.2 and 9.101.2.3 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 of each test lead = 1,0 m;

b) cross section of the conductor = 1,5 mm^2, stranded copper wire (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 9.101.2.2 and 9.101.2.3, 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.

When the test procedures of 6.8.3 are applied to the current sensor, the test leads can be the test leads supplied with the test generator without modification.

9.101.3 Protection against MAINS overvoltages

Voltage measuring circuits RATED for MEASUREMENT CATEGORIES shall have CLEARANCES and CREEPAGE DISTANCES for BASIC INSULATION between MAINS-connected conductive parts of opposite polarity including between the terminations of the devices or components used for limiting the current.

Conformity is checked by inspection and measurement.

In addition, these voltage measuring circuits shall take into consideration expected TRANSIENT OVERVOLTAGES.

Conformity is checked by the following impulse voltage test using the applicable values of Table K.101.

The impulse voltage is applied between each pair of TERMINALS RATED for MAINS voltage measurements while the circuit is working under conditions of NORMAL USE, in combination with the MAINS voltage. The voltage measurement function selectors are set for the proper function and range.

The impulse voltage test is conducted for five impulses of each polarity spaced up to 1 min apart, from a combination wave generator according to IEC 61000-4-5:2014, 6.2. 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 12 Ω maximum for MEASUREMENT CATEGORY II and 2 Ω maximum for MEASUREMENT CATEGORIES III and IV. Resistance may be added in series if needed to raise the impedance.

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 voltages above 400 V a.c. r.m.s. line-to-neutral or 400 V d.c., the test may be performed with an available MAINS voltage source that has a voltage of at least 400 V a.c. r.m.s. or 400 V d.c. The MAINS voltage source does not, in this case, need to match the measuring circuit RATING. For measuring circuits RATED for MAINS in d.c., an a.c. source can be used. When an a.c. source is used, 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 as the cycle, with a phase tolerance of ±10° (see IEC 61000-4-5:2014, 6.2).

NOTE 1 This test can be extremely hazardous. Explosion shields and other provisions can be used to protect personnel performing the test.

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 sensor. 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 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.

9.102 Prevention of HAZARD from arc flash and short-circuits

9.102.1 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 9.102.2 and 9.102.3. All measurements and tests of 9.102.2 and 9.102.3 are done after the JAW ENDS abrasion test of 8.101, if applicable.

9.102.2 Protection against short-circuits during clamping

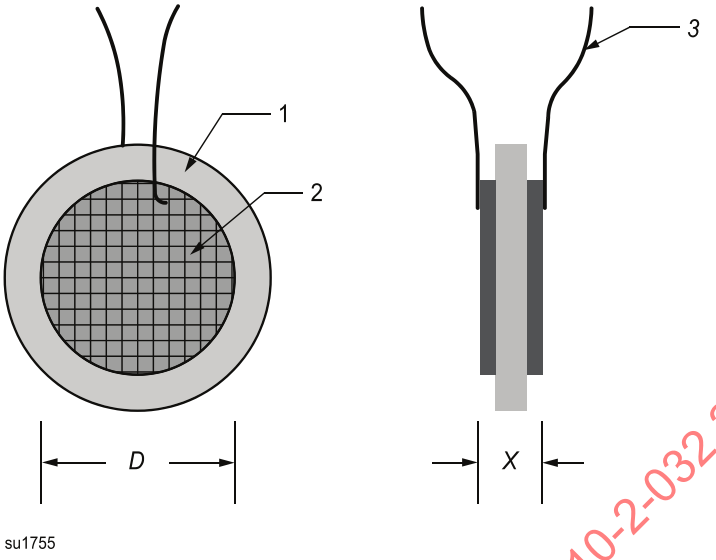
Type A and Type B current sensors shall have additional protection against a short-circuit caused by the JAWS during insertion and removal between conductors and between busbars. This requirement is not applicable to Type A current sensors with fork-style JAWS which do not clamp the conductors or the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

NOTE Examples of protective measures are shrouds, PROTECTIVE FINGERGUARD, 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 107 and of Table 105 for the considered voltage is inserted into the JAW opening as shown in Figure 108.

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 107

Test probe to check protection against short-circuits

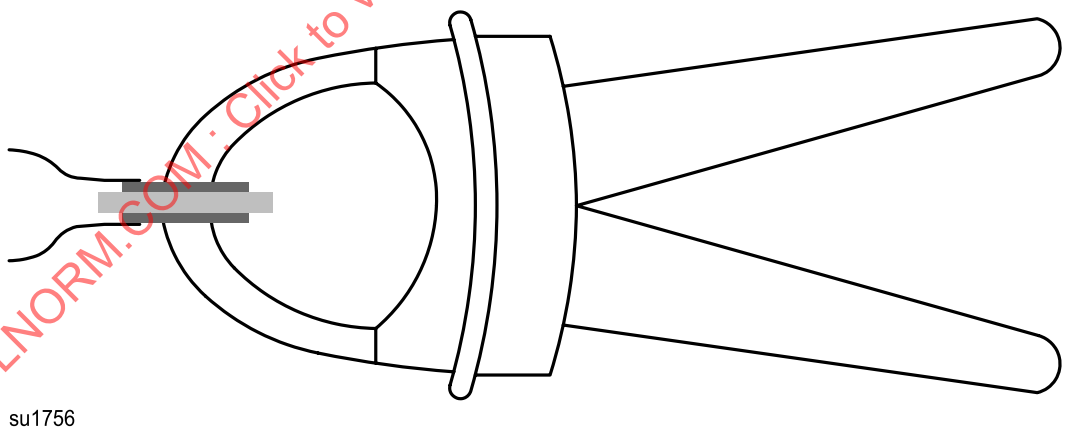


Figure 108

Use of the test probe of Figure 107

Table 105
Thickness of the test probe of Figure 107 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.

9.102.3 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.

10 Equipment temperature limits and resistance to heat

IEC 61010-1:2010, Clause 10 and IEC 61010-1:2010/AMD1:2016, Clause 10 apply 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 in a) or b) 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 306:2013, 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 FINGERGUARD of the current sensor (see 6.101.2) 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 and solid foreign objects

IEC 61010-1:2010, Clause 11 and IEC 61010-1:2010/AMD1:2016, Clause 11 apply.

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

IEC 61010-1:2010, Clause 12 and IEC 61010-1:2010/AMD1:2016, Clause 12 apply.

13 Protection against liberated gases and substances, explosion and implosion

IEC 61010-1:2010, Clause 13 and IEC 61010-1:2010/AMD1:2016, Clause 13 apply.

14 Components and subassemblies

IEC 61010-1:2010, Clause 14 and IEC 61010-1:2010/AMD1:2016, Clause 14 apply except as follows:

Add the following new subclause:

14.101 Probe assemblies and accessories

Probe assemblies and accessories within the scope of IEC 61010-031:2022 shall meet the requirements thereof.

Conformity is checked by inspection of the documentation or by carrying out all the relevant tests of IEC 61010-031:2022.

15 Protection by interlocks

IEC 61010-1:2010, Clause 15 applies.

16 HAZARDS resulting from application

IEC 61010-1:2010, Clause 16 applies.

17 RISK assessment

IEC 61010-1:2010, Clause 17 applies.

Add the following new clause:

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 in a) to c) below:

a) a current measuring circuit which could interrupt the circuit being measured during range changing, or during the use of current sensors with an internal current transformer (see 101.2);

b) a displayed voltage value which can be incorrect or ambiguous (see 101.3);

c) other HAZARDS that could result from REASONABLY FORESEEABLE MISUSE shall be addressed by RISK assessment (see Clause 16 and Clause 17).

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).

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

101.2 Current sensor with an internal current transformer

When the secondary circuit of a current transformer is disconnected from its burden, a high voltage can appear between the ends of the open circuit, and could lead to a hazardous situation.

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 when an interruption of the secondary circuit may occur, 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 Indicating devices

101.3.1 General

No HAZARD shall occur from reading a voltage value when the current sensor is operated for measuring MAINS voltages and in the event of REASONABLY FORESEEABLE MISUSE.

NOTE Current sensors in the scope of this document can have voltage and power measurement features.

A displayed voltage value is considered to be unambiguous when the value is less than 10 % inaccurate, or if there is an indication when the value is out of range, 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 101.3.2, 101.3.3 and 101.3.4 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 current sensor is not required to maintain its normal accuracy during and after the tests.

101.3.2 Battery level

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

Conformity is checked by the following test:

For each measuring circuit TERMINAL RATED for MAINS voltage measurements, the voltage in the dashed list 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 101.3.1 for the meaning of the term "unambiguous".

101.3.3 Over-range indication

The current sensor 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 current sensor is set.

NOTE Examples of ambiguous indications include the following in a) and b), 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 set to each voltage measurement range.

The value of the over-range voltage applied to the TERMINALS is set at 110 % of the RATED voltage measurement range. For measurements 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.

101.3.4 Permanent overvoltages

The current sensor 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 9.101.3 provides requirements for 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 current sensor set to each voltage measurement range.

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

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.

The above test may need to be repeated at any combination of settings, TERMINALS and voltage RATINGS.

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 displayed voltage values shall be unambiguous.

Annexes

All annexes of IEC 61010-1:2010 and IEC 61010-1:2010/AMD1:2016 apply except as follows.

Annex D
(normative)

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

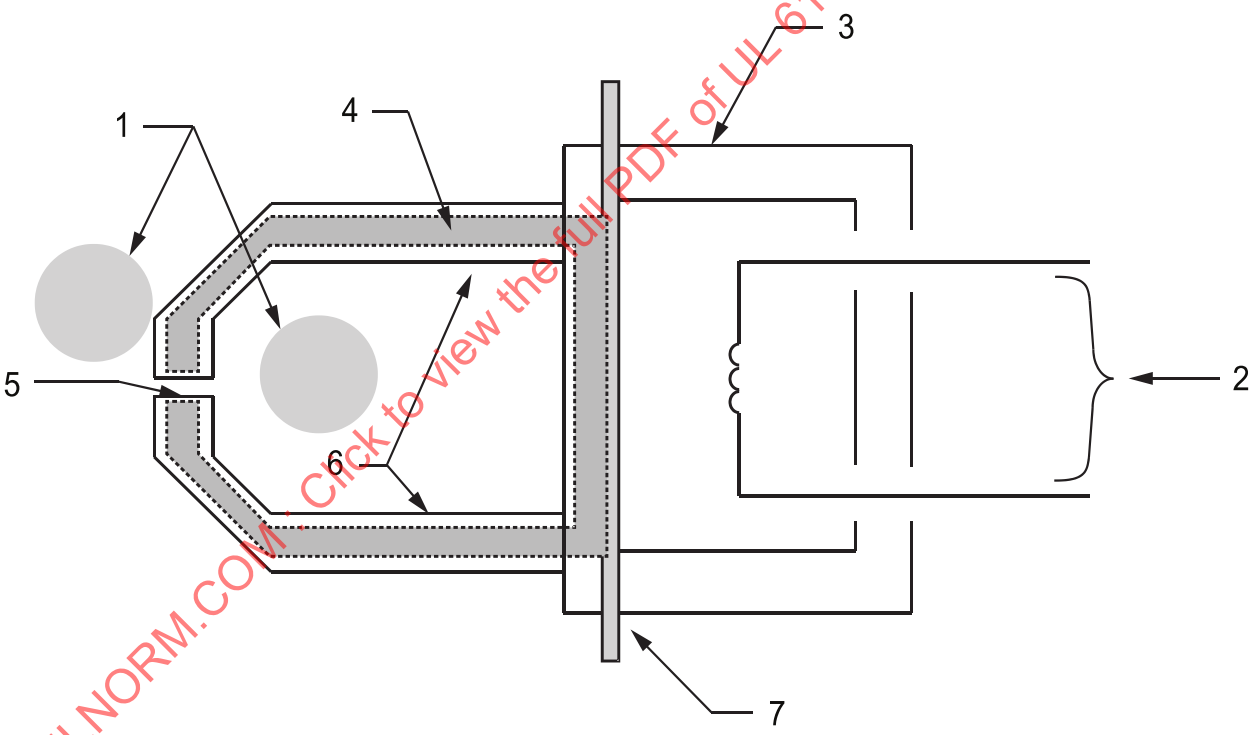
Replace the title of Annex D with the following title:

Annex D
(normative)

Parts between which insulation requirements are specified
(see 6.4, 6.5.3 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.



su1757

Key

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

Figure D.101

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

Table D.101
Insulation requirements for current sensors

Current sensor type	Insulation between parts							
	1 and 2	1 and 3	1 and 4 [a]	2 and 3 [b]	2 and 5 [c]	2 and 6 [b]	3 and 5 [c]	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 headings of 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] 3 and 6 of Figure D.101 are parts of the current sensor enclosure (see also Figure D.2 c) and Figure D.2 d)).

[c] Transients are disregarded for determination of CLEARANCES and test voltages of solid insulation (see Clause K.3).

When applying or removing a current sensor, it is very unlikely that a transient is present at the moment the JAWS ENDS are briefly touching a HAZARDOUS LIVE CONDUCTOR.

It is also very unlikely that an OPERATOR can touch the JAW END while a HAZARDOUS LIVE voltage is applied to the input (see Key [2] of Figure D.101) for example of a CLAMP MULTIMETER, and a transient is present.

Annex F
(normative)

Routine tests

F.1 General

Replace the first sentence with the following text:

The manufacturer shall perform the tests of Clause F.2 to Clause 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 voltage test is the impulse voltage test using the applicable test voltage of Table K.103 or the a.c. voltage test using the applicable test voltage of Table K.104 for the appropriate MEASUREMENT CATEGORY. The impulse voltage test is the 1,2/50 µs test specified in IEC 61180:2016 conducted for a minimum of three pulses of each polarity at 1 s minimum intervals. For the a.c. voltage test, the test voltage is raised to its specified value within 5 s, and maintained for at least 2 s. 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.

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.2 Insulation in secondary circuits

K.2.1 General

Delete the note.

Add the following two new paragraphs and the example at the end of Subclause K.2.1:

The maximum TRANSIENT OVERVOLTAGE level of earthed secondary circuit is assumed to be one level lower from the series of impulse voltages of Table K.101 for the considered nominal a.c. r.m.s. line-to-neutral or d.c. voltage of the primary MAINS CIRCUIT with the same OVERVOLTAGE CATEGORY or MEASUREMENT CATEGORY.

EXAMPLE If the nominal voltage a.c. r.m.s. line-to-neutral voltage of MAINS being measured is 2 000 V in MEASUREMENT CATEGORY III, the applicable impulse voltage is 15 000 V and the lower level is 10 000 V.

CLEARANCES for secondary circuits are determined:

1) for earthed secondary circuits, by the method in K.2.2 or in K.3.2 using the lower TRANSIENT OVERVOLTAGE value of one level, or

2) for all secondary circuits, by the method in K.3.2 method using the U_t value defined in Clause K.4.

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 in circuits not addressed in 6.7, Clause K.1, Clause K.2 or Clause K.101, and for measuring circuits where measurement categories do not apply

K.3.1 General

Replace the text with the following:

The circuits covered by this Clause K.3 have one or more of the following characteristics in a) to g):

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

b) the maximum possible TRANSIENT OVERVOLTAGE is above the level from the series of impulse voltages of Table K.101, assumed for the MAINS CIRCUIT;

c) 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;

d) the TRANSIENT OVERVOLTAGE value where attenuation occurred is determined by the method of Clause K.4;

e) the working voltage is the sum of voltages from more than one circuit, or is a mixed voltage (see also K.3.101);

f) 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;

g) the working voltage has a frequency above 30 kHz.

In cases a) to e), CLEARANCES are determined according to K.3.2.

In cases f) and g), CLEARANCES are determined according to K.3.3.

NOTE 1 CLEARANCES for measuring circuit TERMINALS are defined in 6.6.101.

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

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

K.3.2 CLEARANCE calculation

Replace the existing conformity statement, Table K.15, Table K.16 and Note 2 with the following new conformity statement, Table K.15, Table K.16 and Note 2 (including Example 1 and Example 2).

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 by the d.c. voltage test of 6.8.3.2 for measuring circuits stressed only by d.c. with a duration of at least 5 s, or by the impulse voltage test of 6.8.3.3, using the applicable test voltage of Table K.16 for the required CLEARANCE.

Correction factors of Table 10 are applicable to the values of test voltages.

Table K.15
CLEARANCE values for the calculation of K.3.2

Maximum voltage	CLEARANCE		Maximum voltage	CLEARANCE	
U_m	D_1	D_2	U_m	D_1	D_2
V	mm	mm	V	mm	mm
14,1 to 266	0,010	0,010	4 000	3,00	3,80
283	0,010	0,010	4 530	3,53	4,80
330	0,010	0,010	5 660	4,99	7,15
354	0,012	0,013	6 000	5,50	7,90
453	0,030	0,030	7 070	6,84	9,55
500	0,040	0,040	8 000	8,00	11,0
566	0,053	0,053	8 910	9,37	12,9
707	0,081	0,097	11 300	13,0	17,7
800	0,10	0,13	14 100	16,8	23,2
891	0,12	0,19	17 700	21,8	29,9
1 130	0,22	0,36	22 600	29,2	39,2
1 410	0,43	0,66	28 300	37,6	51,3
1 500	0,50	0,76	35 400	50,8	66,9
1 770	0,77	1,04	45 300	68,0	89,2
2 260	1,26	1,55	56 600	85,0	115

Table K.15 Continued on Next Page

Table K.15 Continued

Maximum voltage	CLEARANCE		Maximum voltage	CLEARANCE	
U_m	D_1	D_2	U_m	D_1	D_2
V	mm	mm	V	mm	mm
2 500	1,50	1,80	70 700	111	148
2 830	1,83	2,20	89 100	148	190
3 540	2,54	3,16	100 000	170	215
Linear interpolation is allowed.					
NOTE See Annex EE.					

Table K.16
Test voltages based on CLEARANCES

Required CLEARANCE	Impulse 1,2/50 µs	a.c. r.m.s. 50/60 Hz	a.c. peak 50/60 Hz or d.c.	Required CLEARANCE	Impulse 1,2/50 µs	a.c. r.m.s. 50/60 Hz	a.c. peak 50/60 Hz or d.c.
mm	V peak	V	V	mm	V peak	V	V
0,010	330	230	330	16,5	14 000	7 600	10 700
0,025	440	310	440	17,0	14 300	7 800	11 000
0,040	520	370	520	17,5	14 700	8 000	11 300
0,063	600	420	600	18,0	15 000	8 200	11 600
0,1	806	500	700	19,0	15 800	8 600	12 100
0,2	1 140	620	880	20	16 400	9 000	12 700
0,3	1 310	710	1 010	25	19 900	10 800	15 300
0,5	1 550	840	1 200	30	23 300	12 600	17 900
1,0	1 950	1 060	1 500	35	26 500	14 400	20 400
1,4	2 440	1 330	1 880	40	29 700	16 200	22 900
2,0	3 100	1 690	2 400	45	32 900	17 900	25 300
2,5	3 600	1 960	2 770	50	36 000	19 600	27 700
3,0	4 070	2 210	3 130	55	39 000	21 200	30 000
3,5	4 510	2 450	3 470	60	42 000	22 900	32 300
4,0	4 930	2 680	3 790	65	45 000	24 500	34 600
4,5	5 330	2 900	4 100	70	47 900	26 100	36 900
5,0	5 720	3 110	4 400	75	50 900	27 700	39 100
5,5	6 100	3 320	4 690	80	53 700	29 200	41 300
6,0	6 500	3 520	4 970	85	56 610	30 800	43 500
6,5	6 800	3 710	5 250	90	59 400	32 300	45 700
7,0	7 200	3 900	5 510	95	62 200	33 800	47 900
7,5	7 500	4 080	5 780	100	65 000	35 400	50 000
8,0	7 800	4 300	6 030	110	70 500	38 400	54 200
8,5	8 200	4 400	6 300	120	76 000	41 300	58 400
9,0	8 500	4 600	6 500	130	81 300	44 200	62 600
9,5	8 800	4 800	6 800	140	86 600	47 100	66 700
10,0	9 100	4 950	7 000	150	91 900	50 000	70 700

Table K.16 Continued on Next Page

Table K.16 Continued

Required CLEARANCE mm	Impulse 1,2/50 µs V peak	a.c. r.m.s. 50/60 Hz V	a.c. peak 50/60 Hz or d.c. V	Required CLEARANCE mm	Impulse 1,2/50 µs V peak	a.c. r.m.s. 50/60 Hz V	a.c. peak 50/60 Hz or d.c. V
10,5	9 500	5 200	7 300	160	97 100	52 800	74 700
11,0	9 900	5 400	7 600	170	102 300	55 600	78 700
11,5	10 300	5 600	7 900	180	107 400	58 400	82 600
12,0	10 600	5 800	8 200	190	112 500	61 200	86 500
12,5	11 000	6 000	8 500	200	117 500	63 900	90 400
13,0	11 400	6 200	8 800	210	122 500	66 600	94 200
13,5	11 800	6 400	9 000	220	127 500	69 300	98 000
14,0	12 100	6 600	9 300	230	132 500	72 000	102 000
14,5	12 500	6 800	9 600	240	137 300	74 700	106 000
15,0	12 900	7 000	9 900	250	142 200	77 300	109 400
15,5	13 200	7 200	10 200	264	149 000	81 100	115 000
16,0	13 600	7 400	10 500				
Linear interpolation is allowed.							

NOTE 2 Two examples of calculations are given below.

D_{BI} is the CLEARANCE for BASIC INSULATION;

D_{RI} is the CLEARANCE for REINFORCED INSULATION.

EXAMPLE 1 CLEARANCE for REINFORCED INSULATION for a WORKING VOLTAGE with peak value of 3 500 V and an additional transient voltage of 4 500 V (this can be expected within an electronic switching-circuit).

U_m is the maximum voltage:

$$U_m = U_w + U_t = (3\,500 + 4\,500)\ \text{V} = 8\,000\ \text{V}$$

$$U_w / U_m = 3\,500 / 8\,000 = 0{,}44 > 0{,}2$$

thus $F = (1{,}25 \times U_w / U_m) - 0{,}25 = (1{,}25 \times 3\,500 / 8\,000) - 0{,}25 = 0{,}297$

D_1 and D_2 values are derived from Table K.15 at 8 000 V:

$D_1 = 8{,}00$ mm, $D_2 = 11{,}0$ mm

$D_{BI} = D_1 + F \times (D_2 - D_1) = 8{,}00 + 0{,}297 \times (11{,}0 - 8{,}00) = 8{,}00 + 0{,}89 = 8{,}89$ mm

CLEARANCE for REINFORCED INSULATION is doubled: $D_{RI} = 2 \times D_{BI} = 17{,}8$ mm.

EXAMPLE 2 CLEARANCE for BASIC INSULATION for a circuit driven from a MAINS transformer connected to an outlet of the distribution system with a MAINS voltage of 230 V and an OVERVOLTAGE CATEGORY II. The circuit includes TRANSIENT OVERVOLTAGE limiting devices (see Clause K.4) which limit the maximum voltage (including transients) in the circuit to 1 000 V.

The peak value U_w of the voltage in the circuit is 150 V.

The maximum value of the voltage U_m is therefore 1 000 V.

$$U_m = 1\,000\ \text{V}$$

$$U_w / U_m = 150 / 1\,000 = 0{,}15 < 0{,}2, \text{ thus } F = 0$$

D_1 value is interpolated from Table K.15.

$D_{BI} = D_1 = 0{,}17$ mm

The CLEARANCE is then corrected for altitude (see Table 10) and the minimum value is checked against POLLUTION DEGREE.

Add the following new subclause and a figure:

K.3.101 CLEARANCES between MAINS CIRCUITS and input/output circuits

CLEARANCES for DOUBLE or REINFORCED INSULATION are based on the sum of the peak WORKING VOLTAGE of the MAINS CIRCUIT and the input/output circuit, and the highest expected additional TRANSIENT OVERVOLTAGE from the MAINS CIRCUIT or the input/output circuit. The calculation method of K.3.2 is used.

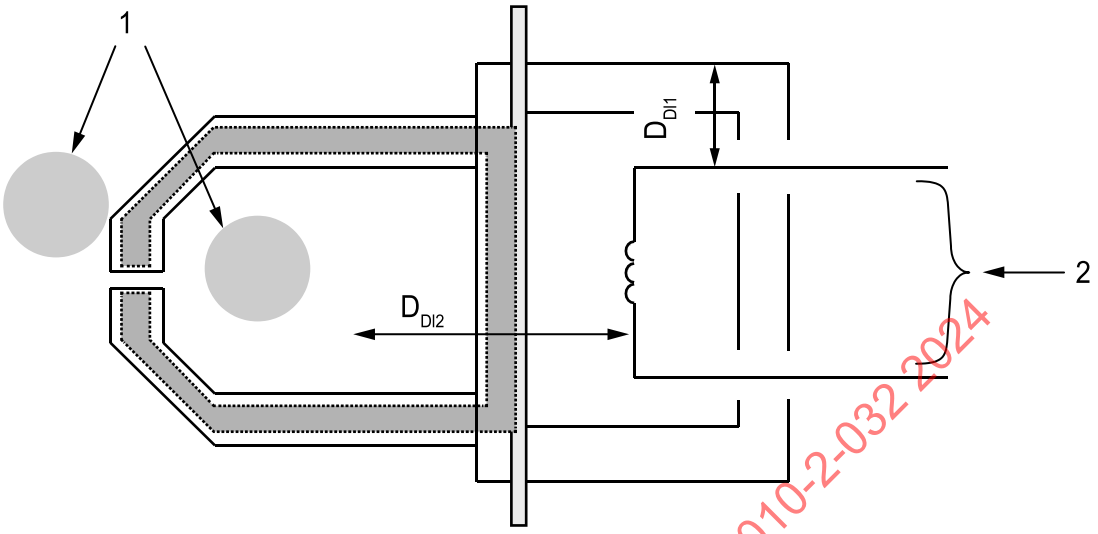
If a protective screen is used, the BASIC INSULATION between the screen and the MAINS CIRCUIT and input/output circuit is determined or calculated separately.

Conformity is checked by inspection and test.

NOTE An example of CLEARANCE calculations for the secondary circuit based on the method in K.3.2 using the lower TRANSIENT OVERVOLTAGE value of one level are given below.

A clamp wattmeter using a type A current sensor is applied to an UNINSULATED CONDUCTOR connected to MAINS voltage of 230 V and with a MEASUREMENT CATEGORY III. A current transformer is located between the MAINS and the secondary circuit. The input voltage for power measurement of the clamp wattmeter is also 230 V a.c.

The HAZARDOUS LIVE UNINSULATED CONDUCTORS within the JAWS and the input/output circuit are insulated by DOUBLE INSULATION (see Figure K.101).



Key

1 230 V a.c. HAZARDOUS LIVE UNINSULATED CONDUCTOR within the JAWS, MEASUREMENT CATEGORY III, 4 000 V TRANSIENT OVERVOLTAGE

2 230 V a.c. input/output, MAINS CIRCUIT, 4 000 V TRANSIENT OVERVOLTAGE

D_{DI1} is the CLEARANCE for DOUBLE INSULATION between the HAND-HELD or hand-manipulated parts and the input/output circuit

D_{DI2} is the CLEARANCE for DOUBLE INSULATION between the HAZARDOUS LIVE UNINSULATED CONDUCTOR within the JAWS or near the JAWS and the input/output circuit

Figure K.101

CLEARANCES between the conductor, the input/output circuit and the enclosure of a Type A current sensor

The 4 000 V TRANSIENT OVERVOLTAGE in the secondary circuits is reduced by one level to 2 500 V as per K.2.1 and Table K.101.

The value of the required CLEARANCE D_{DI1} is directly taken from Table K.102:

for 300 V a.c. r.m.s line-to-neutral voltage of MAINS D_{DI1} = 6 mm.

Required CLEARANCE for D_{DI2} is calculated as follows. D_{BI2} is the CLEARANCE for BASIC INSULATION.

$D_{BI2} = D_1 + F \times (D_2 - D_1)$

U_w = (230 V + 230 V) · 1,414 = 650 V peak

U_t = 4 000 V − 230 V = 3 770 V (the maximum TRANSIENT OVERVOLTAGE value of 2 500 V and 4 000 V only have been considered)

U_m = 3 770 V + 650 V = 4 420 V

$U_w / U_m < 0$, then $F = 0$

D_1 = 4,41 mm from Table K.15

$D_{BI2} = D_1$ = 4,41 mm.

CLEARANCE is doubled for DOUBLE INSULATION: $D_{DI2} = 2 \cdot D_{BI2} = 8{,}82$ mm.

K.4 Reduction of TRANSIENT OVERVOLTAGES by the use of overvoltage limiting devices

Replace the existing title of Clause K.4 with the following title:

K.4 Attenuation of TRANSIENT OVERVOLTAGE levels

Replace the existing text with the following text and add a new table and figure:

Current sensors or parts of current sensors may be used under conditions where TRANSIENT OVERVOLTAGES are reduced. Various technologies of components exist such as transformer, surge protective device (SPD), capacitance, resistance, and these can have different behaviour in terms of TRANSIENT OVERVOLTAGES attenuation.

Attention is drawn to the fact that a surge protective device within the installation or within the current sensors may have to dissipate more energy than a surge protective device at the origin of the installation having a higher protection level (clamping voltage). This applies particularly to the surge protective device with the lowest protection level (clamping voltage).

Determination of the expected attenuated transient is carried out in NORMAL CONDITION by inspection and, in case of doubt, by the following test.

The value of the attenuated transient is measured by applying an impulse voltage to the MAINS and by measuring the remaining transient over the parts where the attenuation is expected (see Figure K.102).

If the ENCLOSURE is metallic, it is connected to earth. For a non-metallic ENCLOSURE, accessible parts of the ENCLOSURE are covered with a metal foil including earth TERMINALS and the metal foil is connected to earth.

The applicable impulse voltage of Table K.101 is generated by a combination wave generator according to IEC 61000-4-5:2014, 6.2 with an effective output impedance of 12 Ω maximum for OVERVOLTAGE or MEASUREMENT CATEGORY II and 2 Ω maximum for OVERVOLTAGE or MEASUREMENT CATEGORIES III and IV while MAINS is supplied. The impulse voltage test is conducted for one impulse of each polarity from the combination wave generator. 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 as the cycle, with a phase tolerance of ±10° (see IEC 61000-4-5:2014, 6.2).

The parts where the attenuation is expected are working under conditions of NORMAL USE. The MAINS voltage used for the test is the maximum RATED line-to-neutral voltage of the MAINS. For circuits RATED for MAINS voltages above 400 V a.c. r.m.s. line-to-neutral or 400 V d.c., the test may be performed with an available MAINS voltage source that has a voltage of at least 400 V a.c. r.m.s. or 400 V d.c. The MAINS voltage source does not need in this case to match the measuring circuit RATING. For circuits RATED for MAINS in d.c., an a.c. source can be used.

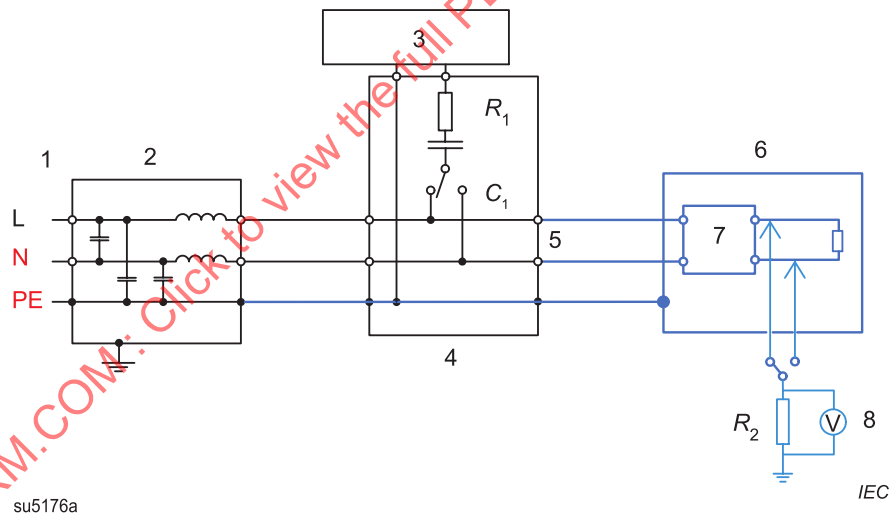
The maximum peak value of the wave shape of each impulse is measured on each part where the attenuation is expected. The maximum peak value when no impulse voltage is applied is also measured. The difference is the additional peak value.

The test is repeated if only one output of the attenuating device can be monitored at the same time. When the attenuating device is a transformer which has multiple transformation ratios, only the outputs from the lowest transformation ratio are monitored. A measuring instrument such as peak voltmeter or oscilloscope which does not affect the measurement is used.

The additional measured peak value is used as the maximum additional TRANSIENT OVERVOLTAGE for CLEARANCE calculation (see K.3.2). The maximum additional TRANSIENT OVERVOLTAGE U_t together with the maximum peak value of the WORKING VOLTAGE U_w forms the maximum impulse voltage U_m.

Table K.101
Impulse voltages for circuits connected to MAINS

Nominal a.c. r.m.s line-to-neutral or d.c. voltage of MAINS V	Impulse voltage V peak		
	OVERVOLTAGE and MEASUREMENT CATEGORY II	OVERVOLTAGE and MEASUREMENT CATEGORY III	OVERVOLTAGE and 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 up to 1 000 V are from IEC 60664-1:2020, Table F.1. Values over 1 000 V are from IEC TS 62993:2017, Table 1.			



Key

1	a.c./d.c. power port	5	EUT port
2	decoupling network	6	current sensor under test (EUT)
3	combination wave generator	7	attenuating device under test
4	coupling network	8	peak voltmeter or oscilloscope

R_1 = 10 Ω and C_1 = 9 µF (according to IEC 61000-4-5:2014, Figure 6)
R_2 is the impedance of the peak voltmeter or oscilloscope (usually 1 MΩ).

Figure K.102

Test circuit for evaluation of TRANSIENT OVERVOLTAGE attenuation

Add the following new clause and four 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 current sensor.

MEASUREMENT CATEGORIES take into account OVERVOLTAGE CATEGORIES, short-circuit current levels, the location where the test or measurement is to be made and some forms of energy limitation or transient protection included in the building installation. When the measuring circuit is used to connect to MAINS, there is a RISK of arc blast. MEASUREMENT CATEGORIES in accordance with Annex AA define the amount of energy available, which may contribute to arc flash (see also BB.2.3).

K.101.2 CLEARANCES

For current sensors 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, but overvoltage limiting devices may be used to reduce the TRANSIENT OVERVOLTAGES to a level consistent with a lower MEASUREMENT CATEGORY (see Clause K.4). Additional marking requirements are given in 5.1.5.2 and 5.1.5.101.

CLEARANCES of measuring circuits RATED for MEASUREMENT CATEGORIES are specified in Table K.102.

NOTE See Annex I for line-to-neutral voltages for common MAINS.

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.

For BASIC INSULATION, SUPPLEMENTARY INSULATION and REINFORCED INSULATION, the minimum CLEARANCE for POLLUTION DEGREE 2 is 0,2 mm and for POLLUTION DEGREE 3 it is 0,8 mm.

Table K.102
CLEARANCES for 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	0,10	0,50	0,10	0,32	1,4
> 50 ≤ 100	0,10	0,50	1,5	0,32	1,4	3,0
> 100 ≤ 150	0,50	1,5	3,0	1,4	3,0	6,0

Table K.102 Continued on Next Page

Table K.102 Continued

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
> 150 ≤ 300	1,5	3,0	5,5	3,0	6,0	10,4
> 300 ≤ 600	3,0	5,5	8,0	6,0	10,4	15
> 600 ≤ 1 000	5,5	8,0	14,0	10,4	15,0	23,9
> 1 000 ≤ 1 500	8,0	11,0	18,0	16,0	22,0	36
> 1 500 ≤ 2 000	14,0	18,0	22,0	28	36	44
> 2 000 ≤ 3 000	18,0	22,0	25,0	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 by the d.c. voltage test of 6.8.3.2 for measuring circuits stressed only by d.c. with a duration of at least 5 s, or by 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 current sensor.

Conformity is checked by both of the following tests:

a) the impulse voltage test of 6.8.3.3 using the applicable test voltage of Table K.103 or, as an alternative, the a.c. voltage test of 6.8.3.1 using the applicable test voltage of Table K.104 with a duration of at least 5 s;

b) for measuring circuits stressed by a.c. or a.c. plus d.c. voltage, the a.c. voltage test of 6.8.3.1 or for measuring circuits stressed only by pure d.c. voltage, the d.c. voltage test of 6.8.3.2, using the test voltage determined by K.101.4.2 with a duration of at least 1 min.

NOTE The test in list item a) above checks the effects of TRANSIENT OVERVOLTAGES, while the test in list item b) checks the effects of long-term stress of solid insulation.

Table K.103
Impulse test voltages for testing electric strength of solid insulation for 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 CATEGORIES II	MEASUREMENT CATEGORIES III	MEASUREMENT CATEGORIES IV	MEASUREMENT CATEGORIES II	MEASUREMENT CATEGORIES III	MEASUREMENT CATEGORIES 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

Table K.104
a.c. test voltages for testing electric strength of solid insulation for 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					
	BASIC INSULATION and SUPPLEMENTARY INSULATION			REINFORCED INSULATION		
	MEASUREMENT CATEGORIES II	MEASUREMENT CATEGORIES III	MEASUREMENT CATEGORIES IV	MEASUREMENT CATEGORIES II	MEASUREMENT CATEGORIES III	MEASUREMENT CATEGORIES 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

K.101.4.2 Long-term stress test voltage value calculation

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

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

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

where

U_T is the a.c. or d.c. test voltage;

U_N is the nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured;

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.

NOTE Parameter values up to 1 000 V are derived from IEC 60364-4-44:2007, 442.2.2 and parameters values over 1 000 V are derived from IEC TS 62993:2017, 6.1.3.1.

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

K.101.4.3 Constructional requirements

K.101.4.3.1 General

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 apply;

2) for moulded and potted parts, the requirements of K.101.4.3.2 apply;

3) for insulating layers of printed wiring boards, the requirements of K.101.4.3.3 apply;

4) for thin-film insulation, the requirements of K.101.4.3.4 apply.

Conformity is checked as specified in K.101.4.3.2 to K.101.4.3.4, and Clause 8, as applicable.

K.101.4.3.2 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.101.4.3.3 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 for measuring circuits RATED for MEASUREMENT CATEGORIES

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

[a] This value is independent of the MEASUREMENT CATEGORY.

[b] This value applies 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 for BASIC INSULATION of Table K.103 or Table K.104 with a duration of at least 5 s.

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 for REINFORCED INSULATION of Table K.103 or Table K.104 with a duration of at least 5 s.

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

K.101.4.3.4 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 for BASIC INSULATION of Table K.103 or Table K.104 with a duration of at least 5 s.