UL 61010-2-034

STANDARD FOR SAFETY

Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use – Part 2-034: Particular Requirements for Measurement Equipment for Insulation Resistance and Test Equipment for Electric Strength

UL Standard for Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use – Part 2-034: Particular Requirements for Measurement Equipment for Insulation Resistance and Test Equipment for Electric Strength, UL 61010-2-034

Second Edition, Dated October 17, 2024

Summary of Topics

This Second Edition of ANSI/UL 61010-2-034 dated October 17, 2024 is an Adoption of IEC 61010-2-034, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use – Part 2-034: Particular Requirements for Measurement Equipment for Insulation Resistance and Test Equipment for Electric Strength (second edition issued July 2023) as a new IEC-based UL standard, UL 61010-2-034, with US National Differences.

The requirements are substantially in accordance with Proposal(s) on this subject dated August 6, 2024.

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OCTOBER 17, 2024

ANSI/UL 61010-2-034-2024

UL 61010-2-034

Standard for Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2-034: Particular Requirements for Measurement Equipment for Insulation Resistance and Test Equipment for Electric Strength

First Edition – January, 2020

Second Edition

October 17, 2024

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

The most recent designation of ANSI/UL 61010-2-034 as an American National Standard (ANSI) occurred on October 17, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page. 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.

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Preface (UL)

This UL Standard is based on IEC Publication 61010-2-034: second edition, Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-034: Particular requirements for measurement equipment for insulation resistance and test equipment for electric strength. IEC publication 61010-2-034 is copyrighted by the IEC.

This edition has been issued to satisfy ULSE Standards policy.

This UL Standard 61010-2-034 Standard for Safety for Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2-034: Particular Requirements for Measurement Equipment for Insulation Resistance and Test Equipment for Electric Strength, 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 61010-2-034, 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.

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NATIONAL DIFFERENCES

National Differences from the text of International Electrotechnical Commission (IEC) Publication 61010-2-034, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2-034: Particular Requirements for Measurement Equipment for Insulation Resistance and Test Equipment for Electric Strength, 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.

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

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**.

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.

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FOREWORD

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL, AND LABORATORY USE – Part 2-034: Particular requirements for measurement equipment for insulation resistance and test equipment for electric strength

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 61010-2-034 has been prepared by IEC technical committee 66: Safety of measuring, control and laboratory equipment. It is an International Standard.

It has the status of a group safety publication in accordance with IEC Guide 104.

This second edition cancels and replaces the first edition published in 2017. This edition constitutes a technical revision.

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

a) in 1.2.1, requirements for protection against hazards which could occur from reading a voltage have been added to the scope;

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

c) in 4.3.2.5, requirements for power supply have been modified;

d) in 4.3.2.6, requirements for inputs/outputs have been modified;

e) in 5.1.5.101.2, minimum ratings for voltage of measuring terminals are required;

f) in 5.4.2, new ratings for documentation have been added;

g) in 5.4.4, new instructions for operation have been added;

h) in 5.101.1, hazard indicators shall be functional in normal condition and in single fault condition;

i) in 6.6.101.1, insulating material of group I may be allowed for determination of creepage distances of measuring circuit terminals;

j) in 6.6.101.2, Clearances and creepage distances above 1 000 V a.c. and 1 500 V d.c. for measuring circuit terminals in unmated position have been defined;

k) in 6.6.101.3, requirements for measuring circuit terminals in partially mated position have been specified;

l) in 6.6.101.4, requirements for measuring circuit terminals in mated position have been specified;

m) Subclause 6.102 replaces 6.9.103 and has been rephrased;

n) new Subclause 9.101 to consider the protection of measuring circuits against the spread of fire and arc flash has been added. Table 102 has been replaced by Table K.101;

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) in 9.101.4, requirements for measuring circuit terminals in mated position have been specified;

r) in 9.101.5, relocation of K.103 of previous edition with numerous technical changes;

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

t) in 101.3, relocation of 101.5 of previous edition, and more requirements added against hazard occurring from reading a voltage value;

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

v) in K.3.2, new Table K.15 and Table K.16 for clearance calculation;

w) in K.3.101, relocation of 6.9.104 of previous edition;

x) in K.101.4.1, new Table K.103 and Table K.104 replace Table K.102, Table K.103 and Table K.104;

y) in K.101.4, the subclause has been reviewed. Tables and tests for solid insulation have been modified. Table K.105 replaces Table K.9;

z) Table K.101, replacement of Table K.106;

aa) Clause K.4, redraft of the clause to propose a method for determination of Ut for circuits which reduce transient overvoltage;

bb) Annex EE: addition of a new informative annex for determination of clearances for Table 101.

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

Draft	Report on voting
66/778/FDIS	66/784/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 measurement equipment for insulation resistance and test equipment for electric strength*.

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:

• the following print types are used:

– requirements: in roman type;

– NOTES: in small roman type;

– *conformity and test: in italic type*;

– terms used throughout this standard which have been defined in Clause 3: SMALL ROMAN CAPITALS;

• 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 61010-2-032 and IEC 61010-2-033 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 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) IEC 61010-2-032 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 have been included in IEC 61010-2-032. Equipment within the scopes of both IEC 61010-2-030 and IEC 61010-2-032 are considered to be covered by the requirements of IEC 61010-2-032.

However, for current sensors in combined equipment with protective bonding and automatic disconnection of the supply, IEC 61010-2-030 and IEC 61010-2-032 are read in conjunction.

3) IEC 61010-2-033 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.

4) This document 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 have been included in this document. However, for equipment within the scope of IEC 61010-2-032 and of this document, 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, IEC 61010-2-032, IEC 61010-2-033 and this document. 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.

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SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL, AND LABORATORY USE – Part 2-034: Particular requirements for measurement equipment for insulation resistance and test equipment for electric strength

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 to equipment for measuring insulation resistance and to equipment for testing electric strength which have an output voltage exceeding 50 V a.c. or 120 V d.c.

This document also applies to combined measuring equipment which has an insulation resistance measurement function or an electric strength test measurement function.

This group safety publication focusing on safety essential requirements is primarily intended to be used as a product safety standard for the products mentioned in the scope, but is also intended to be used by technical committees in the preparation of publications for products similar to those mentioned in the scope of this document, in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications and/or group safety publications in the preparation of its publications.

1.1.2 Equipment excluded from scope

Add the following new items to the list:

aa) IEC 61557-8 (Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 8: Insulation monitoring devices for IT systems);

bb) IEC 61557-9 (Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 9: Equipment for insulation fault location in IT systems).

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 equipment (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 and Clause 101.

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 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 61672-1, *Electroacoustics – Sound level meters – Part 1: Specifications*

IEC 61672-2, *Electroacoustics – Sound level meters – Part 2: Pattern evaluation tests*

with the following new normative references:

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 61672-1:2013, *Electroacoustics – Sound level meters – Part 1: Specifications*

IEC 61672-2:2013, *Electroacoustics – Sound level meters – Part 2: Pattern evaluation tests*
IEC 61672-2:2013/AMD1:2017

Add the following new normative references:

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

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*

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:

3.5 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

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 equipment can be set or, if the equipment is RATED for a greater fluctuation, at any supply voltage within the fluctuation range;

b) the MAINS frequency shall be any RATED frequency;

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

d) equipment powered 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. equipment shall be connected with both reverse and normal polarity.

4.3.2.6 Input and output voltages

Replace the existing title and text with 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.

Add the following new subclause:

4.4.2.101 Surge protective devices

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

5 Marking and documentation

Replace the existing title with the following:

5 Marking, documentation and HAZARD indicator

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

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 equipment within the scope of this document also serve as output TERMINALS.

Except as permitted in 5.1.5.101.5:

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 TERMINALS may have a RATED voltage to earth. For some equipment, the RATED voltage between TERMINALS may be different from the RATED voltage to earth. Markings shall be clear to avoid misunderstanding.

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 equipment), the marking may be on the RATING plate or scale plate, or the TERMINAL may be marked with symbol 14 of Table 1.

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

Conformity is checked by inspection and, if applicable, as specified in 5.1.5.101.2, 5.1.5.101.3 and 5.1.5.101.4, taking the exceptions in 5.1.5.101.5 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 HAZARDOUS LIVE output TERMINALS

Output TERMINALS of measurement equipment for insulation resistance and test equipment for electric strength which can be HAZARDOUS LIVE shall be marked with symbol 12 of Table 1 in close proximity to those TERMINALS.

Conformity is checked by inspection.

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

Measuring circuit TERMINALS do not need to be marked if:

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

b) they are dedicated only for connection to specific TERMINALS of other equipment, 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 is 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 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.

5.4.1 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);

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

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

5.4.2 Equipment RATINGS

Add the following three new items to the list:

aa) the output voltage or voltage range, frequency and current RATING;

bb) for insulation resistance measurement equipment, the RATED line or unit capacitance as required by 6.102;

cc) for insulation resistance measurement equipment intended for use in power station or substation, the RATED induced current (see 9.101.5).

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);

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 5.1.5.101.5).

5.4.4 Equipment

Add the following three new items to the list:

aa) instructions for a daily or routine check to ensure the correct functionality of the equipment before use when one HAZARD indicator has been considered to be sufficient (see 5.101.1);

bb) when performing an a.c. voltage test, instructions to warn the OPERATOR that a hazardous residual voltage can be present after the interruption of the test if the capacitance value of the line or unit under test exceeds the maximum RATED line or unit capacitance value (see 6.102.3);

cc) when an automatic operation to energise the equipment outputs is provided, a warning to keep distance from the unit under test.

Add the following new subclause:

5.101 HAZARD indicator

5.101.1 General

At least one of the following HAZARD indicators shall be provided and it shall be functional in NORMAL CONDITION and in SINGLE FAULT CONDITION of the indicator. One indicator is considered to be sufficient if the manufacturer's instructions or markings require a daily or routine check to ensure the correct functionality of the equipment before use.

a) Indicator light Where an indicator light is provided, it shall illuminate or flash when there are HAZARDOUS LIVE voltages present on the output TERMINALS. It may start illuminating or flashing at any point when the output is activated. The indicator light shall be red in colour. If the indicator light flashes, the frequency shall be 50 cycles per minute to 300 cycles per minute. The duty cycle shall be at least 40 %.

Conformity is checked by inspection and measurement.

b) Variable visible indicator Where a variable visible indicator with contrasting colours is provided, it shall operate when there are HAZARDOUS LIVE voltages present on the output TERMINALS. It may start operating at any point when the output is activated. The visible indicator shall have equally spaced areas of significantly contrasting either colours or patterns or both.

Conformity is checked by inspection.

c) Audible indicator Where an audible indicator is provided, it shall produce a sound with a minimum constant sound pressure level of 70 dBA and a frequency of the fundamental wave lower than 5 kHz to warn the OPERATOR or a bystander when there are HAZARDOUS LIVE voltages present on the output TERMINALS. It may start producing a sound at any point when the output is activated.

Conformity is checked by measuring the maximum A-weighted sound pressure level at the OPERATOR'S position and at bystander positions. The following conditions apply.

1) During measurement, the equipment is fitted and operated as in NORMAL USE.

2) Sound level meters used in the measurement conform either to class 1 of IEC 61672-1:2013 and, when used, integrating sound level meters have been evaluated according to class 1 of IEC 61672-2:2013.

3) The distance between any wall or any other object and the surface of the equipment is not less than 3 m.

5.101.2 HAZARD indicator light for fixed equipment

Where the equipment can be permanently installed, provision shall be made to connect an external HAZARD indicator light.

The power source for the external indicator light may be separated from the equipment.

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:

6.5.2.1 General

Replace the conformity statement with the following:

Conformity is checked as specified in 6.5.2.2 to 6.5.2.6 and 6.5.2.101.

6.5.2.3 PROTECTIVE CONDUCTOR TERMINAL

Replace h) 2) with the following:

h) 2) the PROTECTIVE BONDING shall not be interrupted by any switching or interrupting device. Devices used for indirect bonding in testing and measuring circuits (see 6.5.2.101 are permitted to be part of the PROTECTIVE BONDING.

Add the following new subclause and figure:

6.5.2.101 Indirect bonding for testing and measuring circuits

Indirect bonding establishes a connection between the PROTECTIVE CONDUCTOR TERMINAL and ACCESSIBLE conductive parts if these become HAZARDOUS LIVE as a result of a fault.

Devices to establish indirect bonding are the following:

a) Voltage limiting devices which become conductive when the voltage across them exceeds the relevant levels of 6.3.2 a), with overcurrent protection to prevent damage of the device. The duration of current flow versus the body current shall not exceed the levels of Figure 101.

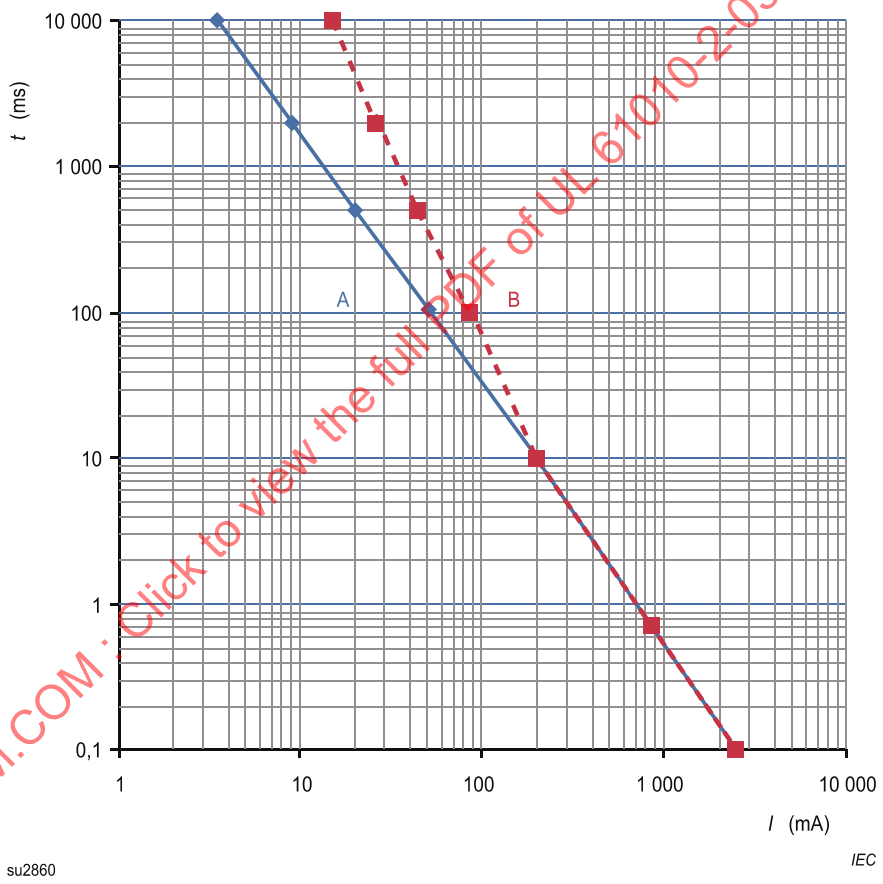
Conformity is checked by connecting the ACCESSIBLE conductive parts to the minimum and the maximum HAZARDOUS LIVE voltage according to the equipment RATINGS while the equipment is operated in NORMAL USE. The current between the ACCESSIBLE conductive parts and the PROTECTIVE CONDUCTOR TERMINAL is measured with the circuit of Figure A.1.

b) Voltage-sensitive tripping devices which interrupt all poles of the supply connected to the MAINS or the HAZARDOUS LIVE voltage source, and connect the ACCESSIBLE conductive parts to the PROTECTIVE CONDUCTOR TERMINAL whenever the voltage across them reaches the relevant levels of 6.3.2 a). The tripping duration versus the current shall not exceed the levels of Figure 101.

Conformity is checked by applying successively the relevant voltage level of 6.3.2 a) and the maximum RATED voltage between the ACCESSIBLE conductive parts and the PROTECTIVE CONDUCTOR TERMINAL. The current between the ACCESSIBLE conductive parts and the PROTECTIVE CONDUCTOR TERMINAL is measured with the circuit of Figure A.1.

Voltage limiting devices or voltage-sensitive tripping devices as defined in a) and b), shall have at least the voltage and current RATINGS of the measuring TERMINALS.

Conformity is checked by inspection.



Key

A current a.c. (mA)

B current d.c. (mA)

NOTE This figure is based on Figure 20 for a.c. currents and Figure 22 for d.c. currents of IEC 60479-1:2018.

Figure 101

Duration of current flow versus body current for a.c. and d.c. currents

6.6 Connections to external circuits

Add the following new subclause 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 HAND-HELD EQUIPMENT 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 circuit TERMINALS in unmated position when RATED voltages are applied to any other TERMINALS of the equipment or when the measuring circuit TERMINALS are energized from inside the equipment.

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 unmated TERMINALS which are separated from other circuits and can be energized only from inside of the equipment by continuous both-hand operation according to 6.101.2, Note c) shall not be HAZARDOUS LIVE 5 s after the OPERATOR releases a switch.

Conformity is checked by inspection.

3) 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 3 a) and 3 b) as follows.

a) For measuring circuit TERMINALS with a voltage RATING up to 20 000 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

Table 101 Continued on Next Page

Table 101 Continued

Maximum voltage applied to the conductive parts of the TERMINAL V	CLEARANCE	
	a.c. r.m.s. mm	d.c. mm
1 500	2,0	1,1
2 000	3,2	1,8
3 000	6,4	3,5
5 000	13	8,3
10 000	30	20
15 000	48	32
20 000	67	44
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 20 000 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 equipment 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.16 for the required CLEARANCE.

Correction factors of Table 10 are applicable to the values of test voltages for CLEARANCES given in Table K.16.

b) The CREEPAGE DISTANCE values shall be at least the applicable CLEARANCE values defined in 3 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 the TERMINAL in the least favourable position.

In addition for equipment RATED for WET LOCATIONS, conductive parts of TERMINALS with voltage RATINGS above 16 V a.c. r.m.s. or 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 which are separated from other circuits and can only be energized from inside the equipment by a continuous both-hand operation according to 6.101.2, d) in Note shall not be HAZARDOUS LIVE 5 s after the OPERATOR released a switch.

ACCESSIBLE parts of other 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 in mated position of other measuring circuits 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 TERMINAL, if applicable:

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

b) highest RATED d.c. voltage;

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

6.7.1.3 CREEPAGE DISTANCES

Add the following new paragraph after the third paragraph:

For HAND-HELD EQUIPMENT not powered from the MAINS or 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 equipment 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 system type and nominal voltages.

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 3) 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 two new subclauses:

6.101 Protection against HAZARDOUS LIVE outputs

6.101.1 Insulation between MAINS CIRCUITS and output circuits

Output circuits shall be separated from the MAINS CIRCUITS by DOUBLE INSULATION, REINFORCED INSULATION or a protective screen connected to the PROTECTIVE CONDUCTOR TERMINAL insulated from the MAINS and the outputs by BASIC INSULATION.

Conformity is checked by inspection and as specified in Clause K.3.

6.101.2 Protection against unintended energising of the outputs

If the equipment outputs could become HAZARDOUS LIVE, they shall be prevented from being energised unintentionally.

NOTE Examples of such methods include:

a) a test energising switch which requires the OPERATOR to apply continuous pressure for a period of at least 1 s;

b) a test energising switch with a key operated mechanism;

c) a test energising switch under a spring loaded cover which shall be lifted to access the switch;

d) two switches simultaneously depressed to activate the test, intended to restrict the OPERATOR'S use of both hands.

An automatic operation to energise the equipment outputs shall be provided with interlocks (see Clause 15) and the documentation shall have a warning that the OPERATOR must keep a certain distance from the unit under test.

Conformity is checked by inspection.

6.101.3 Protection against automatic energising of the outputs

In the event of power failure and subsequent restoration of the power supply, the equipment shall always power on in a safe condition, even if the test energising switch is held on while the power is restored.

Conformity is checked by inspection.

6.102 Discharging residual voltages

6.102.1 General

Voltage tests are likely to charge capacitances of lines or units under test to HAZARDOUS LIVE energy level. No HAZARD shall occur when residual voltages are present as a result of circuits holding a charge after the test has been interrupted in NORMAL USE.

NOTE Removing test leads without stopping the test is not considered as NORMAL USE.

The maximum RATED line or unit capacitance shall be stated in the documentation.

Conformity is checked as specified in 6.102.2 and 6.102.3.

6.102.2 d.c. voltage tests

When performing a d.c. voltage test, the equipment shall be capable of automatically safely discharging the energy stored in the capacitance of the line or unit under test.

The charge time t_c is the time necessary to charge the RATED capacitance up to the maximum RATED output voltage. The discharge time t_d is the time necessary to discharge the RATED capacitance to the levels of 6.3.1. The discharge time t_d shall be less than $4 \times t_c$ or 10 s whichever is greater.

The HAZARD indicator shall be activated during discharge of the line or unit capacitor when HAZARDOUS LIVE voltage is present on the TERMINALS.

Conformity is checked by inspection and the following test.

The equipment is used to charge a capacitor with a resistor in parallel at the fastest charge rate possible while the equipment is set to its maximum RATED output voltage. The charge is achieved when the output voltage is at its RATED value within a tolerance of −0 %, +6 %. The charge time is measured.

The value of the capacitor used for the test is the maximum RATED line or unit capacitance with a tolerance of ±10 %. The value of the resistor in parallel with the capacitor is 100 MΩ with a tolerance of ±5 %.

Then the equipment discharges the capacitor. During discharging, the output voltage is measured with a high impedance external voltmeter which does not affect the test result. When the voltage is equal to or less than the levels of 6.3.1 a), the discharge time is measured and checked against $4 \times t_c$ or 10 s whichever is greater. If the discharging is stopped by the equipment before $4 \times t_c$ or 10 s whichever is greater, the test leads are disconnected and the levels of 6.3.1 c) are checked on the capacitor 10 s later.

The energy stored in the capacitance of the line or unit under test can be significant. Discharging a capacitance shall not create a fire HAZARD in the equipment. The components of the discharge circuit of the equipment shall be selected for the maximum output test voltage, the peak power and the energy stored at the maximum RATED line or unit capacitance.

Conformity is checked by inspection.

6.102.3 a.c. voltage tests

When performing an a.c. voltage test, the ACCESSIBLE parts of the line or unit under test with an internal capacitor shall not be HAZARDOUS LIVE 10 s after interruption of the test.

Documentation shall include instructions to warn the OPERATOR that a hazardous residual voltage can be present after the interruption of the test if the capacitance value of the line or unit under test exceeds the maximum RATED line or unit capacitance value.

Conformity is checked by the measurements of 6.3 to establish that the levels of 6.3.1 c) on the TERMINALS of the capacitor used for the test are not exceeded 10 s after the test has been interrupted.

The equipment charges the capacitor while it is set to its RATED output voltages. The test voltage is applied for 5 s minimum. The value of the capacitor used for the test is the maximum RATED line or unit capacitance with a tolerance of ±10 %. A 100 MΩ resistor with a tolerance of ±5 % is placed in parallel with the capacitor.

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.

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 new subclauses, figure and table:

9.101 Protection of measuring circuits

9.101.1 General

The equipment shall provide protection against fire or arc flash resulting from NORMAL USE and REASONABLY FORESEEABLE MISUSE of measuring circuits, as specified in a) to d) 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 applied on the measuring circuit TERMINALS in a voltage measurement function (see 9.101.3);

c) an extraneous voltage from the distribution system applied on the measuring circuit TERMINALS in an insulation resistance measurement function (see 9.101.4);

d) an induced current applied on the measuring circuit TERMINALS in a voltage or insulation resistance measurement function (see 9.101.5).

Conformity is checked as specified in 9.101.2, 9.101.3, 9.101.4 and 9.101.5 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 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 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 equipment 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 equipment, 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 an 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 equipment.

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

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

c) The a.c. and d.c. RATED breaking capacities of the overcurrent protection device shall exceed, respectively, the possible a.c. and d.c. short-circuit currents. The possible a.c. and d.c. short-circuit currents shall be calculated as the highest RATED 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 equipment and following the protection device in the measuring circuit shall be sufficiently large to prevent arcing after the protection device opens.

Conformity is checked by inspection of the 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 equipment 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 equipment. If the test results in heating of any component, the equipment 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: 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 equipment and if the manufacturer has not specified the test leads, the tests shall be performed with test leads that meet the following specifications in a) to e):

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 equipment, 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 equipment, 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 equipment. 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.

9.101.4 Protection against extraneous voltages from distribution system

Measuring circuits shall withstand an extraneous a.c. or d.c. voltage accidentally applied for a duration of 10 s to the output TERMINALS. The maximum value of the extraneous voltage is 110 % of the highest RATED voltage of the distribution system on which the equipment is intended to perform measurement or tests.

Conformity is checked by the following tests, as applicable.

a) a.c. voltage test

An a.c. test voltage of the maximum value of the a.c. extraneous voltage is applied for a duration up to 10 s under conditions of NORMAL USE, between the output TERMINALS while the equipment is switched off, then on, and then the outputs are energised.

The source of the test voltage shall be able to deliver a current of at least the possible short-circuit current as applicable.

b) d.c. voltage test

A d.c. test voltage of the maximum value of the d.c. extraneous voltage is applied for a duration up to 10 s in both polarities under conditions of NORMAL USE, between the output TERMINALS while the equipment is switched off, then on, and then the outputs are energised.

After the tests, defects, if any, shall be clearly indicated, indications and displayed values shall not lead to unsafe interpretations.

Such defects include reactivation of protective devices by the OPERATOR without any repair. The replacement of fuses accessible to the OPERATOR is considered as reactivation of a protective device.

9.101.5 Protection against currents and voltages induced by the environment

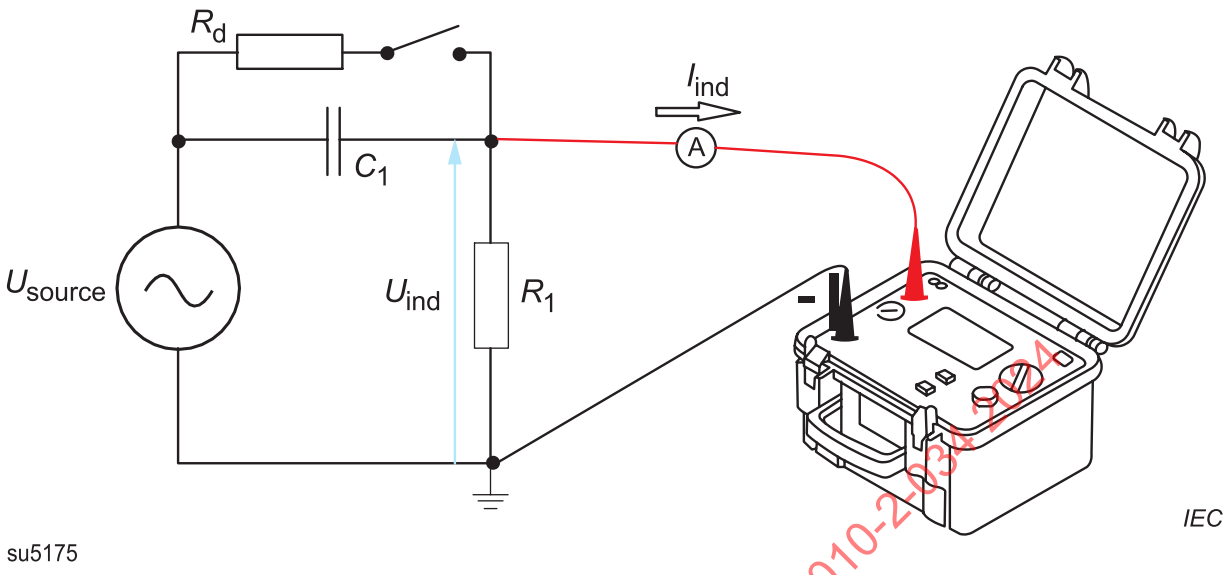
Insulation tests in power stations and substations are carried out on the distribution insulators. The insulator is typically attached to several metres of conductor line which is isolated and grounded prior to testing. Adjacent overhead high-voltage lines can induce current at the MAINS frequency into the line to which is connected the device under test by capacitive coupling. The magnitude of this current is determined by the overhead voltage, the coupling capacitive reactance and the internal impedance of the equipment performing the test.

The induced current flows through the internal impedance of the equipment causing an induced voltage which together with the equipment d.c. test voltage stresses the equipment. The power dissipation in the equipment impedance can lead to a fire HAZARD. The induced voltage can also lead to an electrical HAZARD.

If the equipment is intended for use in these environments, it shall be RATED for induced current and it shall be designed to withstand up to this induced current in all measuring ranges. The RATED induced current shall be stated in the documentation (see 5.4.2 cc)).

Conformity is checked by inspection and the following test when the equipment is set on all measuring functions that are deemed to be susceptible to the effects of the induced current, including on and off positions.

The output voltage U_{source} of the high voltage generator is adjusted so as to have the a.c. induced current I_{Ind} applied between the TERMINALS of the insulation resistance measuring circuits equal to the RATED induced current (see Figure 102). The frequency of the a.c. current is 50 Hz or 60 Hz, whichever represents the worst case. The high voltage generator shall be capable of outputting up to 4 times the maximum RATED output voltage of the equipment. The d.c. output voltage is generated at the highest RATED value when testing in the insulation resistance measurement function. The duration of the test is 10 min.



Key

U_{Source} *output voltage of a high voltage generator at the MAINS frequency (50 Hz or 60 Hz)*

U_{Ind} *a.c. plus d.c. voltage present on the TERMINALS of the equipment*

I_{Ind} *a.c. induced current*

C_1 *coupling capacitor*

R_1 = *100 MΩ*

R_d *resistance for discharging the coupling capacitor after the test*

A ammeter (or a current clamp meter) used to measure the a.c. induced current

Figure 102

Test circuit for induced voltage and current

If the range controls have any effect on the electrical characteristics of the input circuit, the test is repeated during the change of range or function.

The highest a.c. plus d.c. voltage U_{Ind} which appears on the TERMINALS during the test is measured and used by K.3.2 and K.3.101 for determination of the minimum values of the CLEARANCES and by K.3.4 for determination of the minimum values of the CREEPAGE DISTANCES (see also 6.6.101.1 for information about the material group).

The equipment shall be deemed to have failed the test if the induced current is lower than the RATED induced current when U_{source} reaches 4 times the maximum RATED d.c. output voltage.

During and after the test, no HAZARD shall arise as a result of fire, arcing or explosion. No HAZARD shall arise through damage to current limitation devices, or any component intended to provide protection against electric shock, heat, arc or fire, including the ENCLOSURE and traces on the printed wiring board.

10 Equipment temperature limits and resistance to heat

IEC 61010-1:2010, Clause 10 and IEC 61010-1:2010/AMD1:2016, Clause 10 apply.

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 and current sensors within the scope of IEC 61010-2-032 shall meet the requirements thereof.

Conformity is checked by inspection of the documentation or by carrying out all the relevant tests of IEC 61010-2-031:2022 or IEC 61010-2-032 as applicable.

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 equipment shall provide protection against HAZARDS resulting from NORMAL USE and REASONABLY FORESEEABLE MISUSE of measuring circuits, as specified in a) to d) below:

a) a current measuring circuit which could interrupt the circuit being measured during range changing, or during the use of current transformers without internal protection (see 101.2),

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

c) for measuring circuits that include one or more FUNCTIONAL EARTH TERMINALS, if the equipment is operated with a disconnected PROTECTIVE CONDUCTOR TERMINAL and if the OPERATOR unintentionally connects a FUNCTIONAL EARTH TERMINAL to the RATED voltage of the other TERMINALS,

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

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

101.2 Current measuring circuits

Current measuring circuits shall be so designed that, when range changing takes place, there shall be no interruption which could cause a HAZARD.

Conformity is checked by inspection, and, when an interruption of the current measuring circuit may occur, by causing the device to switch the maximum RATED current 6 000 times.

Current measuring circuits intended for connection to current transformers without internal protection shall be adequately protected to prevent a HAZARD arising from interruption of these circuits during operation.

NOTE 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.

Conformity is checked by an overload test at a value of 10 times the maximum RATED current for 1 s, and, if applicable, by causing the equipment to switch the maximum RATED current 6 000 times. No interruption which could cause a HAZARD shall occur during the tests.

101.3 Indicating devices

101.3.1 General

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

A displayed voltage value is considered to be unambiguous when the value is less than 10 % inaccurate, or if there is an indication 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.

101.3.2 Battery level

A voltage value displayed by the equipment 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 equipment 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 equipment is set.

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

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

b) digital meters which show a low value when the true value is above the range maximum (for example 1 001,5 V displayed as 001,5 V);

c) chart recorders which print a trace at the edge of the chart, thus indicating a value at the range maximum when the true value is higher.

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 equipment 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 equipment 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 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 the subclause:

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 of MAINS CIRCUIT 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 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 for 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 K.101, assumed for the MAINS circuit;

c) the maximum possible TRANSIENT OVERVOLTAGE is limited by the supply source or within the equipment 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:

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

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

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.

$U_m = 1\,000$ V

$U_w / U_m = 150 / 1\,000 = 0{,}15 < 0{,}2$, 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 two figures:

K.3.101 CLEARANCES between MAINS circuits and output circuits

CLEARANCES for DOUBLE or REINFORCED INSULATION are based on the sum of the peak WORKING VOLTAGE of the MAINS CIRCUIT and the output circuit, and the highest expected additional TRANSIENT OVERVOLTAGE from the MAINS CIRCUIT or the 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 output circuit is determined or calculated separately.

If the equipment is RATED for induced current (see 9.101.5), the WORKING VOLTAGE shall take into account the value of the induced voltage U_{Ind} superimposed on the output circuit voltage.

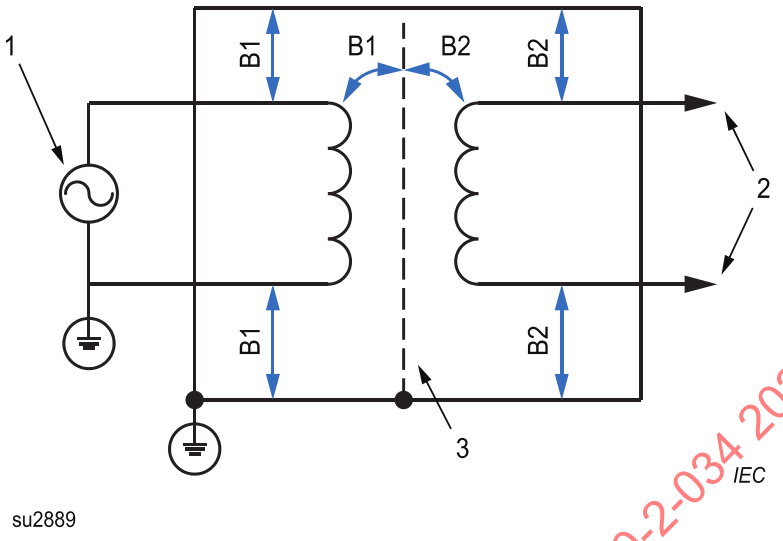
Conformity is checked by inspection and test.

NOTE Two examples of calculations based on the K.3.2 method using the lower TRANSIENT OVERVOLTAGE value of one level are given below.

A circuit is 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. A linear transformer is located between the MAINS and the secondary circuit. The output voltage of the equipment is 2 000 V a.c.

EXAMPLE 1 Circuit with a protective screen

The transformer has a protective bonding screen. The MAINS CIRCUIT and the output are insulated by BASIC INSULATION (see Figure K.101).



Key

1 230 V a.c. mains circuit, OVERVOLTAGE CATEGORY II, 2 500 V transient overvoltage

2 2 000 V a.c. output, secondary circuit, 1 500 V TRANSIENT OVERVOLTAGE

3 Protective bonding screen

Figure K.101

Circuit with protective screen

The 2 500 V TRANSIENT OVERVOLTAGE in the secondary circuits is reduced by one level to 1 500 V as per K.2.1 and Table K.101.

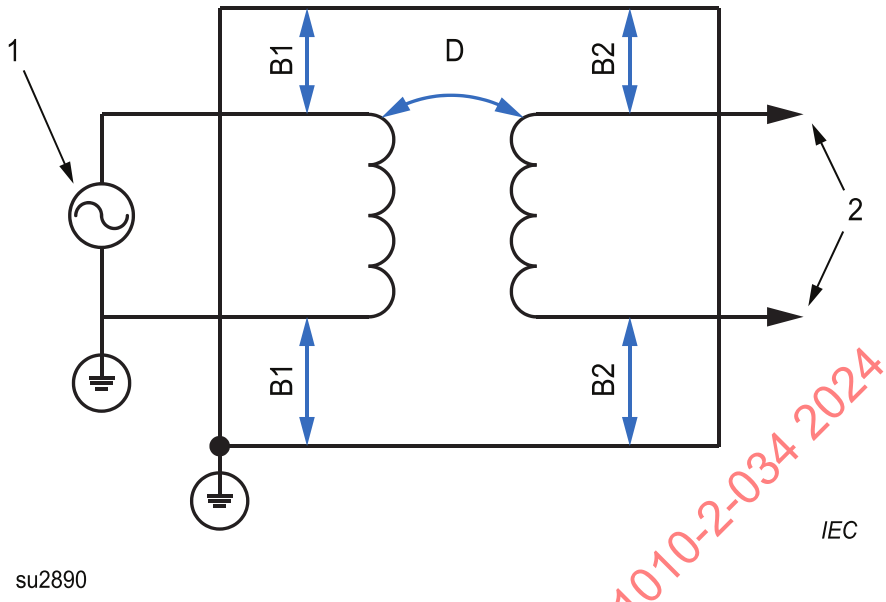
The values of the required CLEARANCES for B1 and B2 are directly taken from Table 4 and Table 6.

CLEARANCE for B1 is derived from Table 4 for 300 V a.c. MAINS = 1,5 mm.

CLEARANCE for B2 is derived from Table 6 for 2 000 V a.c. secondary = 5,30 mm.

EXAMPLE 2 Circuit with double insulation

The MAINS CIRCUIT and the output are insulated by DOUBLE INSULATION (see Figure K.102).



Key

1 230 V a.c. MAINS circuit, OVERVOLTAGE CATEGORY II, 2 500 V TRANSIENT OVERVOLTAGE

2 2 000 V a.c. output, secondary circuit, 1 500 V TRANSIENT OVERVOLTAGE

Figure K.102

Circuit with DOUBLE INSULATION

The 2 500 V TRANSIENT OVERVOLTAGE in the secondary circuits is reduced by one level to 1 500 V as per K.2.1 and Table K.101.

The values of the required CLEARANCES for B1 and B2 are directly taken from Table 4 and Table 6 .

CLEARANCE for B1 is derived from Table 4 for 300 V a.c. MAINS = 1,5 mm.

CLEARANCE for B2 is derived from Table 6 for 2 000 V a.c. secondary = 5,30 mm.

D_{BI} is the CLEARANCE for BASIC INSULATION

D_{DI} is the CLEARANCE for DOUBLE INSULATION

Required CLEARANCE for the DOUBLE INSULATION is calculated as follows:

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

U_w = (230 V + 2 000 V) × 1,414 = 3 154 V peak

U_t = 2 500 V − 325 V = 2 175 V

U_m = 2 175 V + 3 154 V = 5 329

$F = (1{,}25 \times U_w / U_m) - 0{,}25 = 0{,}48$

D_1 = 4,56 mm, D_2 = 6,46 mm from Table K.15.

CLEARANCE for BASIC INSULATION: $D_{BI} = 4{,}56 + 0{,}48 \times (6{,}46 - 4{,}56) = 5{,}47$ mm.

CLEARANCE is doubled for DOUBLE INSULATION: $D_{DI} = 2 \times D_{BI} = 5{,}47 \times 2 = 10{,}9$ 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 OVERVOLTAGES levels

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

Equipment or parts of equipment 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 equipment 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.103).

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 PROTECTIVE EARTH TERMINALS and FUNCTIONAL 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.

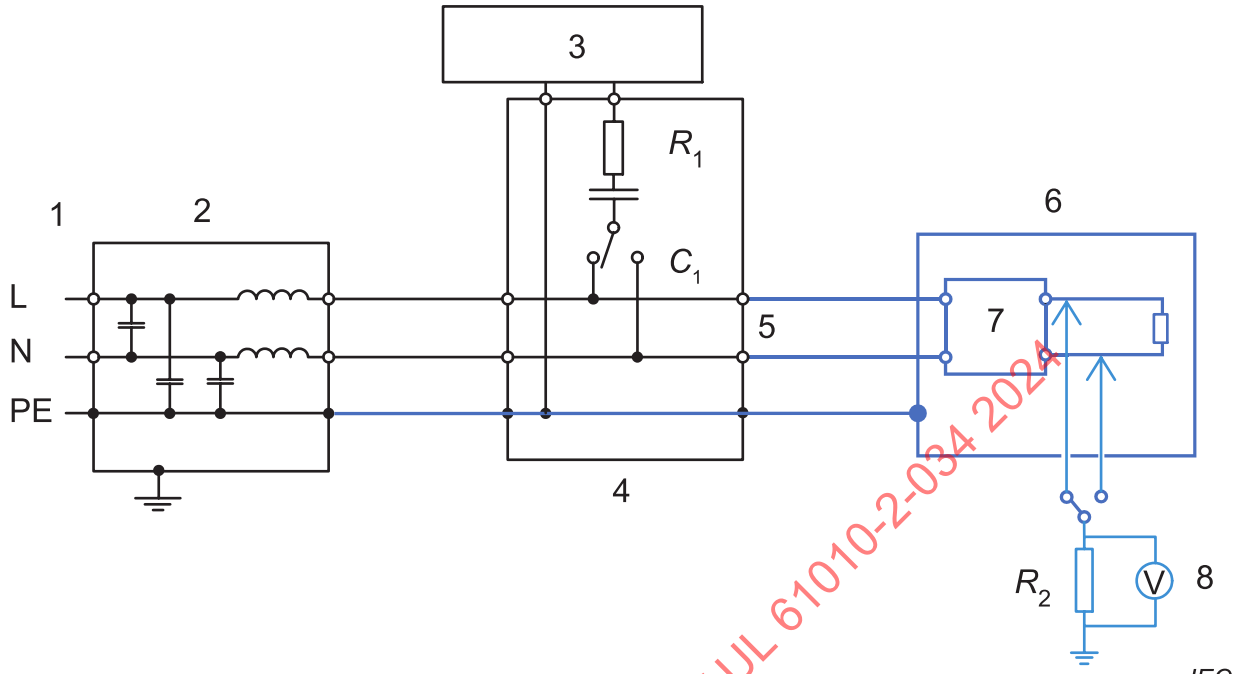
The maximum peak value of the wave shape of each impulse is measured on each part where the attenuation is expected. The maximum peak value when no impulse voltage is applied is also measured. The difference is the additional peak value.

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 OVERVOLTAGES 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 equipment 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.103

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 measuring equipment.

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 equipment intended to be powered from the circuit being measured, CLEARANCES for the MAINS CIRCUIT shall be designed according to the requirements of the RATED MEASUREMENT CATEGORY, 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 equipment is RATED to operate at an altitude greater than 2 000 m, the values for CLEARANCES shall be multiplied by the applicable factor of Table K.1.

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

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	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
> 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 equipment.

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 Test a) checks the effects of transient overvoltages, while test 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 CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV
≤ 50	500	800	1 500	800	1 280	2 400
> 50 ≤ 100	800	1 500	2 500	1 280	2 400	4 000
> 100 ≤ 150	1 500	2 500	4 000	2 400	4 000	6 400
> 150 ≤ 300	2 500	4 000	6 000	4 000	6 400	9 600
> 300 ≤ 600	4 000	6 000	8 000	6 400	9 600	12 800
> 600 ≤ 1 000	6 000	8 000	12 000	9 600	12 800	19 200
> 1 000 ≤ 1 500	8 000	10 000	15 000	13 500	17 900	27 100
> 1 500 ≤ 2 000	12 000	15 000	18 000	21 400	27 100	32 000
> 2 000 ≤ 3 000	15 000	18 000	20 000	27 100	32 000	36 000

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 CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV
≤ 50	370	500	840	500	720	1 300
> 50 ≤ 100	500	840	1 400	720	1 300	2 200
> 100 ≤ 150	840	1 400	2 200	1 300	2 200	3 500
> 150 ≤ 300	1 400	2 200	3 300	2 200	3 500	5 100
> 300 ≤ 600	2 200	3 300	4 300	3 500	5 100	7 000
> 600 ≤ 1 000	3 300	4 300	6 600	5 100	7 000	10 000
> 1 000 ≤ 1 500	4 300	5 400	8 200	7 400	9 700	15 000
> 1 500 ≤ 2 000	6 600	8 200	9 700	12 000	15 000	18 000
> 2 000 ≤ 3 000	8 200	9 700	11 000	15 000	18 000	20 000

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 parameter 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 ofK.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.