UL 61010-2-030

STANDARD FOR SAFETY

Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2-030: Particular Requirements for Equipment Having Testing or Measuring Circuits

UL Standard for Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2-030: Particular Requirements for Equipment Having Testing or Measuring Circuits, UL 61010-2-030

Second Edition, Dated December 21, 2018

Summary of Topics

This revision of ANSI/UL 61010-2-030 dated May 24, 2023 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

Adoption of IEC 61010-2-030, Edition 2.0 (issued 2017-01), Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2-030: Particular Requirements for Equipment Having Testing or Measuring Circuits, as an IEC-based UL Standard, UL 61010-2-030, Second Edition with US National Differences.

As noted in the Commitment for Amendments statement located on the back side of the title page, ULSE and CSA are committed to updating this harmonized standard jointly. However, the revision pages dated May 24, 2023 will not be jointly issued by ULSE and CSA as these revision pages only address UL ANSI approval dates.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated March 24, 2023.

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ULSE Inc.
UL 61010-2-030
Second Edition

Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2-030: Particular Requirements for Equipment Having Testing or Measuring Circuits

December 21, 2018

(Title Page Reprinted: May 24, 2023)

This national standard is based on IEC 61010-2-030, Second Edition (2017).

ANSI/UL 61010-2-030-2018 (R2023)

Commitment for Amendments

This standard is issued jointly by the Canadian Standards Association (operating as “CSA Group”) and ULSE Inc. (ULSE). Comments or proposals for revisions on any part of the standard may be submitted to CSA Group or ULSE at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of CSA Group and ULSE. CSA Group and ULSE will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue.

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This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. The technical content of IEC and ISO publications is kept under constant review by IEC and ISO. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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This ANSI/UL Standard for Safety consists of the Second Edition including revisions through May 24, 2023. The most recent designation of ANSI/UL 61010-2-030 as a Reaffirmed American National Standard (ANS) occurred on May 24, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

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

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PREFACE

This is the harmonized CSA Group and ULSE standard for safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for equipment having testing or measuring circuits. It is the second edition of CSA-C22.2 No. 61010-2-030 and the second edition of UL 61010-2-030. This edition of CSA C22.2 No. 61010-2-030 supersedes the previous edition published in 2012.

This harmonized standard is based on IEC 61010-2-030, second edition: Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for equipment having testing or measuring circuits, issued January 2017. IEC 61010-2-030 is copyrighted by the IEC.

This harmonized standard was prepared by CSA Group and ULSE.

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

This standard was reviewed by the CSA Subcommittee on Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, under the jurisdiction of the CSA Technical Committee on Consumer and Commercial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee. This standard has been developed in compliance with the Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is to be considered a minimum quantity.

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.

This CSA-C22.2 No. 61010-2-030, Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for equipment having testing or measuring circuits is to be used in conjunction with the third edition of CAN/CSA-C22.2 No. 61010-1. The requirements for testing and measuring circuits are contained in this Part 2 Standard and CAN/CSA-C22.2 No. 61010-1. Requirements of this Part 2 Standard, where stated, amend the requirements of CAN/CSA-C22.2 No. 61010-1. Where a particular subclause of CAN/CSA-C22.2 No. 61010-1 is not mentioned in CSA-C22.2 No. 61010-2-030, the CAN/CSA-C22.2 No. 61010-1 Part 1 subclause applies.

This UL Standard 61010-2-030 Standard for Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for equipment having testing or measuring circuits, is to be used in conjunction with the third edition of UL 61010-1. The requirements for testing and measuring circuits 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 61010-2-030, the UL 61010-1 subclause applies.

Level of Harmonization

This standard adopts the IEC text with national differences.

This standard is published as an identical standard for CSA Group and ULSE.

An identical standard is a standard that is exactly the same in technical content except for national differences resulting from conflicts in codes and governmental regulations. Presentation is word for word except for editorial changes.

All national differences from the IEC text are included in the CSA Group and ULSE versions of the standard. While the technical content is the same in each organization's version, the format and presentation may differ.

Reasons for Differences From IEC

Differences from the IEC are being added in order to address safety and regulatory situations present in Canada and the US.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

IEC Copyright

For CSA Group, the text, figures, and tables of International Electrotechnical Commission Publication 61010-2-030 Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for equipment having testing or measuring circuits, copyright 2017, are used in this standard with the consent of the International Electrotechnical Commission. The IEC Foreword and Introduction are not a part of the requirements of this standard but are included for information purposes only.

NATIONAL DIFFERENCES

National Differences from the text of International Electrotechnical Commission (IEC) Publication 61010-2-030, Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for equipment having testing or measuring circuits, copyright 2017 are indicated by notations (differences) and are presented in bold text. The national difference type is included in the body.

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

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

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

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

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

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

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

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

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

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

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FOREWORD

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL, AND LABORATORY USE – Part 2-030: Particular requirements for equipment having testing or measuring circuits

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.

International Standard IEC 61010-2-030 has been prepared by IEC technical committee 66: Safety of measuring, control and laboratory equipment.

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 2010. This edition constitutes a technical revision.

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

a) Reference to IEC 61010-031 for probe assemblies and IEC 61010-032 for current sensors has been added.

b) Indirect bonding for testing and measuring circuits has been modified, in particular to take into account the duration of current flow versus body current for a.c. and d.c. currents according to IEC TS 60479-1 and IEC TS 60479-2.

c) CLEARANCE and CREEPAGE DISTANCE for WET LOCATIONS and for measuring circuit TERMINAL exceeding 1 000 V a.c. or d.c have been specified.

d) The voltage source for testing overvoltage limiting component or circuit may be limited to 400 V.

e) Requirements against TRANSIENT OVERVOLTAGES for MAINS voltage measuring circuits have been added.

f) Requirements for measuring circuits from 1 000 V d.c. to 1 500 V d.c. have been added.

g) The corrigendum has been included in Table K.102 to Table K.104.

h) Requirements for reduction of TRANSIENT OVERVOLTAGES have been modified.

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

j) Flowchart for insulation according to the type of circuit has been added in a new Annex DD.

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

FDIS	Report on voting
66/613/FDIS	66/621/RVD

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

This Part 2-030 is to be used in conjunction with the latest edition of IEC 61010-1. It was established on the basis of the third edition (2010) of IEC 61010-1, including its amendment 1 (2016).

This Part 2-030 supplements or modifies the corresponding clauses in IEC 61010-1 so as to convert that publication into the IEC standard: *Particular requirements for equipment having testing or measuring circuits*.

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

In this standard:

a) the following print types are used:

– requirements: in roman type;

– NOTES: in small roman type;

– *conformity and test: in italic type;*

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

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

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

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

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

• reconfirmed,

• withdrawn,

• replaced by a revised edition, or

• amended.

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

101DV DE *Modification to add the following to the 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 “Part 1” refer to CAN/CSA-C22.2 No. 61010-1 and UL 61010-1.

No Text on This Page

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 than one, particular Part 2 of the standard which are read in conjunction with the Part 1 requirements.

This Part 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.

Part 2-032 specifies the safety requirements for HAND-HELD and hand-manipulated current sensors (see Clause 1 of Part 2-032). Requirements of Part 2-030 have been included in Part 2-032. Equipment within the scopes of Part 2-030 and Part 2-032 are considered to be covered by the requirements of Part 2-032.

Part 2-033 specifies the safety requirements for HAND-HELD MULTIMETERS and other METERS that have a primary purpose of measuring voltage on a live MAINS. Requirements of Part 2-030 have been included in Part 2-033. Parts of equipment within the scopes of Part 2-030 and Part 2-033 are considered to be covered by the requirements of Part 2-033.

Part 2-034 specifies the safety requirements for measurement equipment for insulation resistance and test equipment for electric strength which are connected to units, lines or circuits for test or measurement purposes. Requirements of Part 2-030 have been included in Part 2-034. Equipment within the scopes of Part 2-030 and Part 2-034 are considered to be covered by the requirements of Part 2-034.

However, for equipment within the scope of Part 2-032, Part 2-033 and Part 2-034, the standards are read in conjunction.

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SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL, AND LABORATORY USE – Part 2-030: Particular requirements for equipment having testing or measuring circuits

1 Scope and object

This clause of Part 1 is applicable except as follows:

1.1.1 Equipment included in scope

Replacement:

Replace the text with the following:

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

This part of IEC 61010 specifies safety requirements for equipment having testing or measuring circuits which are connected for test or measurement purposes to devices or circuits outside the measurement equipment itself.

These include measuring circuits which are part of electrical test and measurement equipment, laboratory equipment, or process control equipment. The existence of these circuits in equipment requires additional protective means between the circuit and an OPERATOR.

NOTE These testing and measuring circuits can, for example:

– measure voltages in circuits of other equipment,

– measure temperature of a separate device via a thermocouple,

– measure force on a separate device via a strain gauge,

– inject a voltage onto a circuit to analyse a new design.

Equipment having these testing and measuring circuits may be intended for performing tests and measurements on hazardous conductors, including MAINS conductors and telecommunication network conductors. See Annex BB for considerations of HAZARDS involved in various tests and measurements.

2 Normative references

This clause of Part 1 is applicable except as follows:

Replacement:

Replace

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

with the following new reference:

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

Addition:

Add the following new normative reference:

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 (for Canada only):*

The following National Standard of Canada, published by CSA Group, is an adoption of an IEC Standard.

The requirements of the CSA Group Standard shall take precedence over the International Standard on which it is based; any reference within CSA-C22.2 No. 61010-2-030 to the International Standard shall be replaced by a reference to the equivalent Canadian Standard. Any reference to International Standards that are adopted as National Standards of Canada subsequent to the publication of CSA-C22.2 No. 61010-2-030 shall be replaced by the relevant National Standard of Canada.

CAN/CSA-C22.2 No. 61010-2-032:14 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.

3 Terms and definitions

This clause of Part 1 is applicable except as follows:

3.5 Safety terms

Replacement:

Replace the definition of 3.5.4 with the following new definition:

3.5.4
MAINS
low-voltage electricity supply system

Addition:

Add the following new definition:

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

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

4 Tests

This Clause of Part 1 is applicable.

5 Marking and documentation

This clause of Part 1 is applicable except as follows:

5.1.5 TERMINALS, connections and operating devices

Addition:

Add the following new subclause:

5.1.5.101 Measuring circuit TERMINALS

5.1.5.101.1 General

Except as permitted in 5.1.5.101.4:

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

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

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

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

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 and 5.1.5.101.3, taking the exceptions in 5.1.5.101.4 into account.

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

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

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

Conformity is checked by inspection.

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

Symbol 14 of Table 1 shall be marked for measuring circuit TERMINALS RATED for connection to voltages above the levels of 6.3.1, but that are not RATED for measurements within MEASUREMENT CATEGORIES II, III or IV (see also 5.4.1 bb)).

Conformity is checked by inspection.

5.1.5.101.4 Permanently connected, dedicated, or low voltage measuring circuit TERMINALS

Measuring circuit TERMINALS do not need to be marked if:

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

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

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

NOTE Examples of acceptable indications that the inputs are intended to be below 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, is below 30 V a.c.

Conformity is checked by inspection.

5.4.1 General

Addition:

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

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

bb) for measuring circuits that do not have a RATING for MEASUREMENT CATEGORY II, III or IV, but could be misused by connection to such circuits, a warning not to use the 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 must not be used.

5.4.3 Equipment installation

Addition:

Add the following new items to the list:

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

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

6 Protection against electric shock

This clause of Part 1 is applicable except as follows:

6.1.2 Exceptions

Add the following new item to the list:

aa) locking or screw-held type measuring TERMINALS, including TERMINALS which do not require the use of a TOOL.

6.5.2.1 General

Replacement:

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

Replacement:

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.

Addition:

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 breakdown of the device. The duration versus the current shall not exceed the levels of Figure 101.

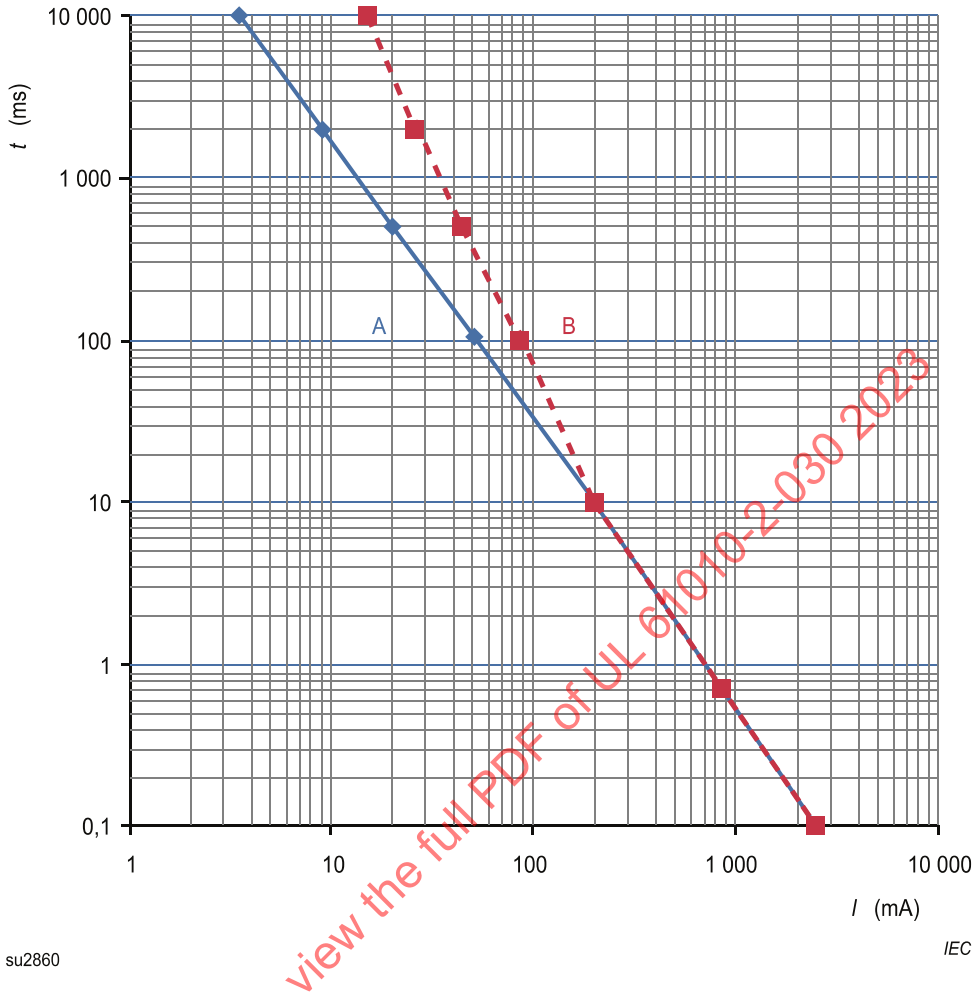
Conformity is checked by connecting the ACCESSIBLE conductive parts to the maximum HAZARDOUS LIVE voltage according to the equipment RATINGS while the equipment is operated in NORMAL USE. The current between the ACCESSIBLE conductive parts and the PROTECTIVE CONDUCTOR TERMINAL is measured with the circuit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

b) Voltage-sensitive tripping devices which interrupt all poles of the MAINS supply 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 IEC TS 60479-1:2005, Figures 20 and 22, and IEC TS 60479-2:2007, Figure 20.

Figure 101

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

6.6 Connections to external circuits

Addition:

Add the following new subclauses:

6.6.101 Measuring circuit TERMINALS

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

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

b) for TERMINALS with voltage RATING exceeding 1 000 V a.c. or 1 500 V d.c., 2,8 mm for the CLEARANCE and CREEPAGE DISTANCE from the closest approach of the test finger touching the external parts of the TERMINAL in the least favourable position.

Additionally, TERMINALS with voltage RATING exceeding 1 000 V a.c. or 1 500 V d.c. shall withstand the voltage test of 6.8 with a test voltage equal to the RATED voltage of the TERMINAL multiplied by 1,25 applied between the closest approach of the test finger touching the external parts of the TERMINAL in the least favourable position and the other measuring circuit TERMINALS.

EXAMPLE For a 4 000 V r.m.s. RATED voltage, the test voltage is 5 000 V r.m.s. (7 070 V peak). The calculated clearance is 13,1 mm according to D2 in Table K.15. For homogeneous fields, a lower CLEARANCE value can be achieved by testing (see IEC 60664-1 for more information about homogeneous fields).

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

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

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

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

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

6.6.102 Specialized measuring circuit TERMINALS

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

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

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

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

b) highest RATED d.c. voltage;

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

6.7.1.3 CREEPAGE DISTANCES

Addition:

Add the following new paragraph after the third paragraph:

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

6.7.1.5 Requirements for insulation according to type of circuit

Replacement:

Replace the text with the following:

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

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

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

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

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

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

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

1) the maximum possible TRANSIENT OVERVOLTAGE is limited by the supply source or within the 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 of MEASUREMENT CATEGORIES II, III and IV.

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

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

NOTE 4 The assumed transient level for MAINS is defined in IEC 60364-4-44:2007/AMD1:2015, Table 443.2.

7 Protection against mechanical HAZARDS

This clause of Part 1 is applicable.

8 Resistance to mechanical stresses

This clause of Part 1 is applicable.

9 Protection against the spread of fire

This clause of Part 1 is applicable.

10 Equipment temperature limits and resistance to heat

This clause of Part 1 is applicable.

11 Protection against HAZARDS from fluids and solid foreign objects

This clause of Part 1 is applicable.

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

This clause of Part 1 is applicable.

13 Protection against liberated gases and substances, explosion and implosion

This clause of Part 1 is applicable.

14 Components and subassemblies

This clause of Part 1 is applicable except as follows:

Addition:

Add the following new subclauses:

14.101 Circuits used to limit TRANSIENT OVERVOLTAGE in measuring circuits used to measure MAINS

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

Conformity is checked by applying five positive and five negative impulses with the applicable impulse voltage of Table 102, spaced up to 1 min apart, from a hybrid impulse generator (see IEC 61180-1). The generator produces an open-circuit voltage waveform of 1,2/50 µs, a short-circuit current waveform of 8/20 µs, with an output impedance (peak open-circuit voltage divided by peak short-circuit current) of 2 Ω for MEASUREMENT CATEGORIES III and IV or 12 Ω for MEASUREMENT CATEGORIES II. Resistance may be added in series if needed to raise the impedance.

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

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

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

The overvoltage limiting component or circuit shall not rupture or overheat during the test. If the results of the test are questionable or inconclusive, the test is to be repeated two more times.

Table 102
Impulse voltages

Nominal a.c. r.m.s line-to-neutral or d.c. voltage of MAINS being measured V	Impulse voltage V		
	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV
≤ 50	500	800	1 500
> 50 ≤ 100	800	1 500	2 500
> 100 ≤ 150	1 500	2 500	4 000
> 150 ≤ 300	2 500	4 000	6 000
> 300 ≤ 600	4 000	6 000	8 000
> 600 ≤ 1 000	6 000	8 000	12 000
> 1 000 ≤ 1 500 [a]	8 000	10 000	15 000

[a] Only for d.c. voltage.

14.102 Probe assemblies and accessories

Probe assemblies and accessories within the scope of IEC 61010-031, and current sensors within the scope of IEC 61010-2-032 shall meet the requirements thereof.

Conformity is checked by inspection.

15 Protection by interlocks

This clause of Part 1 is applicable.

16 HAZARDS resulting from application

This clause of Part 1 is applicable.

17 RISK assessment

This clause of Part 1 is applicable.

Addition:

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 below.

a) If a HAZARD could result, a current measuring circuit shall not interrupt the circuit being measured during range changing, or during the use of current transformers without internal protection (see 101.2).

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

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

d) For measuring circuits that include one or more FUNCTIONAL EARTH TERMINALS, a RISK assessment (see Clauses 16 and 17) shall address the HAZARDS that may result if the equipment is operated with a disconnected PROTECTIVE CONDUCTOR TERMINAL and if the operator unintentionally connects a FUNCTIONAL EARTH TERMINAL to any RATED voltage for any other TERMINAL.

NOTE Oscilloscopes and spectrum analyzers are examples of equipment that often include FUNCTIONAL EARTH TERMINALS in the measuring circuit. In many cases, the OPERATOR will disconnect the PROTECTIVE CONDUCTOR TERMINAL so that the FUNCTIONAL EARTH TERMINAL can float above earth potential. This allows the OPERATOR to make a floating measurement, but introduces a HAZARD. If the OPERATOR inadvertently connects the FUNCTIONAL EARTH TERMINAL to a HAZARDOUS LIVE voltage, then the chassis of the measuring equipment can also be connected to the HAZARDOUS LIVE voltage, and the OPERATOR or a bystander could receive an electric shock from the chassis.

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

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

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

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 Protection against mismatches of inputs and ranges

101.3.1 General

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

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

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

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

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

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

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

101.3.2 Protection by a certified overcurrent protection device

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

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

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

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

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

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

Conformity is checked by inspection of the 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.

101.3.3 Protection by uncertified current limitation devices or by impedances

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

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

a) An appropriate single component which is constructed, selected, and tested so that safety and reliability for protection against relevant HAZARDS are assured. In particular, the component shall:

1) be RATED for the maximum voltage that may be present in NORMAL CONDITION or during the REASONABLY FORESEEABLE MISUSE event;

2) if a resistor, be RATED for twice the power or energy dissipation that may result in NORMAL CONDITION or from the REASONABLY FORESEEABLE MISUSE event;

3) meet the applicable CLEARANCE and CREEPAGE DISTANCE requirements of Annex K for BASIC INSULATION between its terminations.

b) A combination of components which shall:

1) withstand the maximum voltage that may be present in NORMAL CONDITION or during the REASONABLY FORESEEABLE MISUSE event;

2) be able to dissipate the power or energy that may result in NORMAL CONDITION or from the REASONABLY FORESEEABLE MISUSE event;

3) meet the applicable CLEARANCE and CREEPAGE DISTANCE requirements of Annex K for BASIC INSULATION between the terminations of the combination of components.

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

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

The possible a.c. and d.c. short-circuit currents are calculated as the highest RATED voltage for any TERMINAL divided by the impedance of the current-limited measuring circuit, taking the impedance of the test leads specified in 101.3.4 into account. 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. During the test, the voltage output of the source is measured. If the source voltage decreases by more than 20 % for more than 10 ms, the test is considered inconclusive and is repeated with a lower impedance source.

During and after the test, no HAZARD shall arise, nor shall there be any evidence of fire, arcing, explosion, or damage to impedance 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.

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

101.3.3DV 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.

101.3.4 Test leads for the tests of 101.3.2 and 101.3.3

The tests of 101.3.2 and 101.3.3 shall be performed with all test leads that are included with or supplied by the manufacturer for use with the equipment, and if the manufacturer hasn't specified the test leads, the tests shall be performed with test leads that meet the following specifications:

a) length = 1 m;

b) cross section of the conductor = 1,5 mm^2, stranded copper wire;

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

c) equipment connector compatible with the measuring circuit TERMINALS;

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

e) arranged as straight as possible.

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

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

101.4 Protection against MAINS overvoltages

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

Conformity is checked by inspection and measurement.

The measuring circuit TERMINALS of a voltage measuring circuit that is RATED for MEASUREMENT CATEGORIES III or IV shall withstand the applicable TRANSIENT OVERVOLTAGE of Table K.106 with the voltage measurement function selectors set for the proper function and range, without damage which could cause a HAZARD.

Conformity is checked by the following impulse voltage test using the applicable impulse voltage of Table 102.

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

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

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

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

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

The wave shape of each impulse shall be observed (see Note 2). Distortions of the impulse voltage which do not change from impulse to impulse may be caused by operation of an overvoltage limiting device and do not indicate a (partial) breakdown of solid insulation.

No 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. 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 may be repeated in the course of an impulse.

101.5 Over-range indication

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

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

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

b) digital meters which show a low value when the true value is above the range maximum (for example 1 001,5 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 inspection and by provoking an over-range condition.

Annexes

All Annexes of Part 1 are applicable, except as follows:

Annex K
(normative)

Insulation requirements not covered by 6.7

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

Replacement:

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

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

K.3.1 General

Replacement:

Replace the text with the following:

These circuits have one or more of the following characteristics:

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

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

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

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

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

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

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

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

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

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

Addition:

Add the following new clauses and tables:

K.101 Insulation requirements for measuring circuits of MEASUREMENT CATEGORIES II, III and IV

K.101.1 General

Measuring circuits are subjected to WORKING VOLTAGES and transient stresses from the circuits to which they are connected during measurement or test. When the measuring circuit is used to measure MAINS,

the transient stresses can be estimated by the location within the installation at which the measurement is performed. When the measuring circuit is used to measure any other electrical signal, the transient stresses shall be considered by the OPERATOR to ensure that they do not exceed the capabilities of the measuring equipment.

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

K.101.2 CLEARANCES

For equipment intended to be powered from the circuit being measured, CLEARANCES for the MAINS CIRCUIT shall be designed according to the requirements of the RATED MEASUREMENT CATEGORY, but overvoltage limiting devices may be used to reduce the TRANSIENT OVERVOLTAGES to a level consistent with a lower MEASUREMENT CATEGORY (see Clause K.102). Additional marking requirements are in 5.1.5.2 and 5.1.5.101.

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

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

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

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

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

Table K.101
CLEARANCES for MEASUREMENT CATEGORIES II, III and I

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	CLEARANCE mm					
	BASIC INSULATION and SUPPLEMENTARY INSULATION			REINFORCED INSULATION		
	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV
≤ 50	0,04	0,1	0,5	0,1	0,3	1,5
> 50 ≤ 100	0,1	0,5	1,5	0,3	1,5	3,0
> 100 ≤ 150	0,5	1,5	3,0	1,5	3,0	6,0
> 150 ≤ 300	1,5	3,0	5,5	3,0	5,9	10,5
> 300 ≤ 600	3,0	5,5	8	5,9	10,5	14,3
> 600 ≤ 1 000	5,5	8	14	10,5	14,3	24,3
> 1 000 ≤ 1 500[a]	8	11	18	14,3	19,4	31,4
[a] Only for d.c. voltage.						

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

K.101.3 CREEPAGE DISTANCES

The requirements of K.2.3 apply.

Conformity is checked as specified in K.2.3.

K.101.4 Solid insulation

K.101.4.1 General

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

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

Conformity is checked by both of the following tests:

a) the a.c. voltage test of 6.8.3.1 with a duration of at least 5 s or the impulse voltage test of 6.8.3.3 or, for measuring circuits stressed only by d.c., the d.c. voltage test of 6.8.3.2 with a duration of at least 5 s, using the applicable test voltage of Table K.102, Table K.103 or Table K.104;

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

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

Table K.102
Test voltages for testing electric strength of solid insulation in measuring circuits of MEASUREMENT CATEGORY II

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	Test voltage			
	5 s a.c. test V r.m.s.		Impulse test V peak	
	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION
≤ 150	840	1 390	1 550	2 500
> 150 ≤ 300	1 390	2 210	2 500	4 000
> 300 ≤ 600	2 210	3 510	4 000	6 400
> 600 ≤ 1 000	3 310	5 400	6 000	9 600
> 1 000 ≤ 1 500[a]	4 260	7 400	8 000	12 800
[a] Only for d.c. voltage.				

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

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	Test voltage			
	5 s a.c. test V r.m.s.		Impulse test V peak	
	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION
≤ 150	1 390	2 210	2 500	4 000
> 150 ≤ 300	2 210	3 510	4 000	6 400
> 300 ≤ 600	3 310	5 400	6 000	9 600
> 600 ≤ 1 000	4 260	7 400	8 000	12 800
> 1 000 ≤ 1 500[a]	5 330	9 250	10 000	16 000
[a] Only for d.c. voltage.				

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

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	Test voltage			
	5 s a.c. test V r.m.s.		Impulse test V peak	
	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION	BASIC INSULATION and SUPPLEMENTARY INSULATION	REINFORCED INSULATION
≤ 150	2 210	3 510	4 000	6 400
> 150 ≤ 300	3 310	5 400	6 000	9 600
> 300 ≤ 600	4 260	7 400	8 000	12 800
> 600 ≤ 1 000	6 600	11 940	12 000	19 200
> 1 000 ≤ 1 500[a]	8 250	14 930	15 000	24 000
[a] Only for d.c. voltage.				

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

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

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

1) for solid insulation used as an ENCLOSURE or PROTECTIVE BARRIER, the requirements of Clause 8;

2) for moulded and potted parts, the requirements of K.101.4.2;

3) for insulating layers of printed wiring boards, the requirements of K.101.4.3;

4) for thin-film insulation, the requirements of K.101.4.4.

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

K.101.4.2 Moulded and potted parts

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

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

K.101.4.3 Insulating layers of printed wiring boards

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

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

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

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

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

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

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

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

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

K.101.4.4 Thin-film insulation

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

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

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

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

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

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

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

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

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

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

K.102 Reduction of TRANSIENT OVERVOLTAGES by the use of overvoltage limiting devices

TRANSIENT OVERVOLTAGES in a circuit may be limited by combinations of circuits or components. Components suitable for this purpose include varistors and gas-filled surge arrestors.

If the overvoltage limiting device or circuit is intended to reduce TRANSIENT OVERVOLTAGES so that the circuit following it may have reduced CLEARANCES, a RISK assessment (see Clause 17) shall be performed, taking into account both of the following aspects:

a) Even under SINGLE FAULT CONDITIONS, the circuit shall reduce TRANSIENT OVERVOLTAGES to a lower voltage value which depends on the design.

SINGLE FAULT CONDITION includes a short and open circuit of MOV (metal oxide varistor).

b) The circuit shall operate as intended even after withstanding repeated TRANSIENT OVERVOLTAGES.

See Table K.106 for the maximum TRANSIENT OVERVOLTAGE that could occur according to the MEASUREMENT CATEGORY and to the voltage of the MAINS being measured.

Conformity is checked by evaluation of the RISK assessment documentation to ensure that the RISKS have been eliminated or that only TOLERABLE RISKS remain.

Table K.106
Maximum TRANSIENT OVERVOLTAGES

Nominal a.c. r.m.s. lineto-neutral or d.c. voltage of MAINS being measured V	Maximum TRANSIENT OVERVOLTAGE V peak		
	MEASUREMENT CATEGORY II [a]	MEASUREMENT CATEGORY III [a]	MEASUREMENT CATEGORY IV [a]
≤ 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[b]	8 000	10 000	15 000

[a] MEASUREMENT CATEGORIES II, III and IV apply to measurements on MAINS only up to 1 000 V a.c. r.m.s and 1 500 V d.c.

[b] Only for d.c. voltage.