

INTERNATIONAL STANDARD



GROUP SAFETY PUBLICATION

Safety requirements for electrical equipment for measurement, control, and laboratory use –
Part 2-030: Particular requirements for equipment having testing and or measuring circuits



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GROUP SAFETY PUBLICATION

**Safety requirements for electrical equipment for measurement, control, and laboratory use –
Part 2-030: Particular requirements for equipment having testing and or measuring circuits**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL, AND LABORATORY USE –

Part 2-030: Particular requirements for equipment having testing ~~and~~ or measuring circuits

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 61010-2-030 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 Tables K.102 to 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.

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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.

SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL, AND LABORATORY USE –

Part 2-030: Particular requirements for equipment having testing ~~and~~ 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 ~~and~~ 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 1 These testing and measuring circuits ~~may~~ 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.

~~NOTE 2 Testing and measuring circuits that are not within the scope of this Part 2 are considered to be covered by the requirements of Part 1.~~

~~NOTE 3~~ Equipment ~~containing~~ 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*

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 ~~CIRCUITS~~ to which they are intended to be connected

Note 1 to entry: MEASUREMENT CATEGORIES take into account OVERVOLTAGE CATEGORIES, short-circuit current levels, the location in the building installation 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.

NOTE 1 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. ~~Some instruments may have a measurement~~ For some equipment, the RATED voltage (between TERMINALS) may be different from the RATED voltage to earth. Markings ~~should~~ 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.

NOTE 2 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.

NOTE Marking more than one type of MEASUREMENT CATEGORY and its RATED voltage to earth is permissible ~~(see also 5.1.5.101.1, Note 1).~~

Conformity is checked by inspection.

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

Symbol 14 of Table 1 shall be marked for measuring circuit TERMINALS RATED for connection to voltages above the levels of 6.3.1, but that are not RATED for measurements within MEASUREMENT CATEGORIES II, III or IV (see also 5.4.1 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 ~~less than~~ 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 ~~33~~ 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 ~~CIRCUITS~~, and a detailed RATING including TRANSIENT OVERVOLTAGES (see AA.2.4 for more information).

NOTE Some equipment may have multiple MEASUREMENT CATEGORY RATINGS for the same measuring circuit. For such equipment, the documentation ~~needs to~~ *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 ~~permanently connected~~ measuring circuit TERMINALS *intended for permanent connection* and that are RATED for MEASUREMENT CATEGORIES II, III or IV, information regarding the MEASUREMENT CATEGORY, RATED ~~maximum WORKING~~ voltages or RATED ~~maximum~~ currents, as applicable (see 5.1.5.101.2);
- bb) for ~~permanently connected~~ measuring circuit TERMINALS *intended for permanent connection* and that are not RATED for MEASUREMENT CATEGORIES II, III or IV, information regarding the RATED ~~maximum WORKING~~ voltages, RATED ~~maximum~~ currents, and RATED ~~maximum~~ 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.

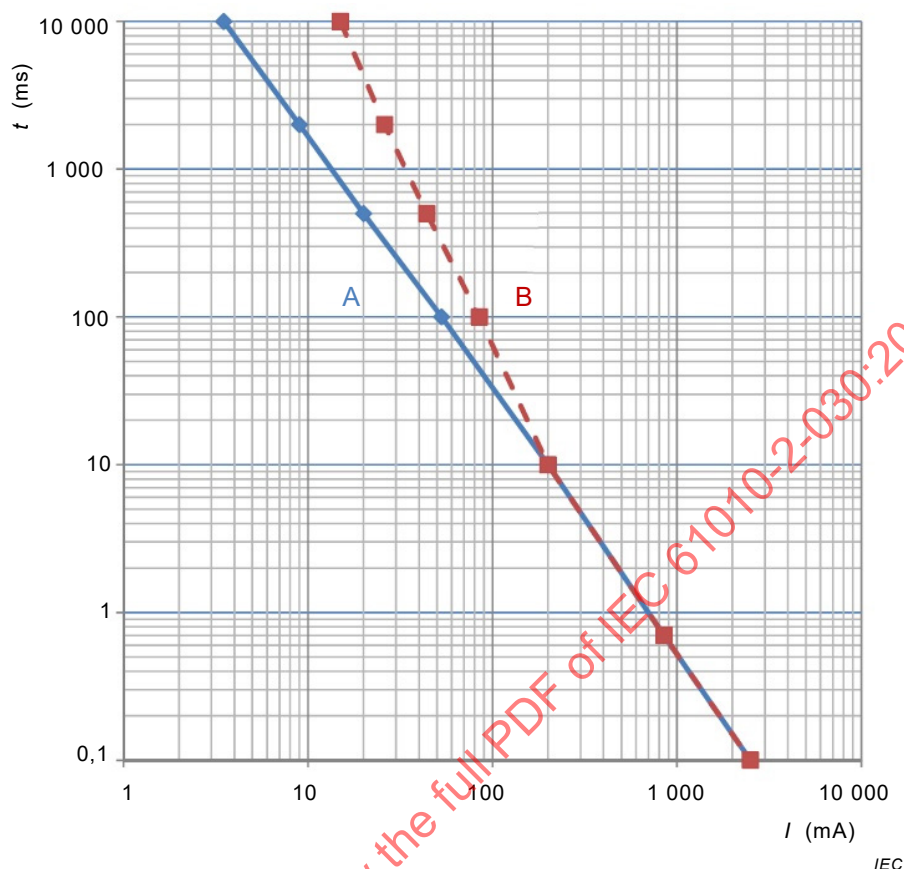
Conformity is checked by connecting the ACCESSIBLE conductive parts to the ~~MAINS supply TERMINALS while the equipment is connected to the MAINS supply as~~ maximum HAZARDOUS LIVE voltage according to the equipment RATINGS while the equipment is operated in NORMAL USE. The ~~voltage current between the ACCESSIBLE conductive parts and the PROTECTIVE CONDUCTOR TERMINAL shall not exceed the relevant levels of 6.3.2 a) for more than 0,2 s~~ 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 tripping action shall take place within 0,2 s. 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 ~~maximum~~ highest RATED voltage is applied to other measuring circuit TERMINALS on the equipment shall be separated by at least:

- 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 D_2 in Table K.15. For homogeneous fields, a lower CLEARANCE value can be achieved by testing (see IEC 60664-1 for more information about homogeneous fields).

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.	~~V d.c.~~	mm
~~≥ 33~~ $> 30 \leq 300$	~~$\geq 70 \leq 414$~~	0,8
$> 300 \leq 600$	~~$> 414 \leq 848$~~	1,0
$> 600 \leq 1\,000$	~~$> 848 \leq 1\,414$~~	2,6
$> 1\,000 \leq 1\,500^a$		2,8
NOTE ~~Values are determined by calculation for REINFORCED INSULATION. Transients are not taken into account.~~ 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 ~~maximum~~ 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:

- ~~maximum~~ highest RATED a.c. voltage at any RATED MAINS frequency;
- ~~maximum~~ highest RATED d.c. voltage;
- ~~maximum~~ 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.

~~6.9 Constructional requirements for protection against electric shock~~~~*Add a new subclause:*~~~~**6.9.101 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 value.~~

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

If control of TRANSIENT OVERVOLTAGES is employed in a measuring circuit used to measure MAINS, ~~any~~ 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 ~~withstand~~ voltage of Table 102, spaced up to 1 min apart, from a hybrid impulse generator (see IEC 61180-1). The generator ~~shall~~ produces an open-circuit voltage waveform of 1,2/50 μ s, a short-circuit current waveform of 8/20 μ s, 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 impulse is applied while the circuit is working under conditions of normal use, in combination with the mains. The voltage is the maximum rated line-to-neutral voltage of the mains being measured.~~

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

~~No HAZARD shall arise in the event that the component ruptures or overheats during the test. If a rupture occurs, no part of the component shall bridge safety-relevant insulation. If the component overheats, it shall not heat other materials to their self-ignition points. Tripping the circuit breaker of the MAINS installation is an indication of failure.~~

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 ~~withstand~~ voltages

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	Impulse ~~withstand~~ voltage V		
	MEASUREMENT CATEGORY II	MEASUREMENT CATEGORY III	MEASUREMENT CATEGORY IV
≤ 50	500	800	1 500
> 50 ≤ 100	800	1 500	2 500
> 100 ≤ 150	1 500	2 500	4 000
> 150 ≤ 300	2 500	4 000	6 000
> 300 ≤ 600	4 000	6 000	8 000
> 600 ≤ 1 000	6 000	8 000	12 000
> 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 ~~should~~ inadvertently connects the functional earth terminal to a hazardous live voltage, then the chassis of the measuring equipment ~~may~~ 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 inspection~~, by an overload test at a value of 10 times the maximum RATED current for 1 s, and, if applicable, by causing the ~~device~~ 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 ~~maximum~~ 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 1 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.

NOTE 2 TERMINALS that are clearly not of similar types and that will not retain the ~~TERMINALS~~ 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 ~~should be~~ 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 ~~maximum~~ highest RATED ~~WORKING~~ 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 ~~maximum~~ highest RATED voltage for any TERMINAL is applied to the TERMINALS of the overcurrent-protected measuring circuit for 1 min. ~~The source of the test voltage shall be capable of delivering 500 VA. During and after the test, no damage to the equipment shall occur.~~

101.3.3 Protection by uncertified current limitation devices or by impedances

Devices used for current limitation shall be capable of safely withstanding, dissipating, or interrupting the energy that will ~~be applied as a result of short-circuit current~~ 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 REINFORCED BASIC INSULATION between its terminations.
- b) A combination of components which shall:
- 1) withstand the maximum voltage that may be present in NORMAL CONDITION or during the REASONABLY FORESEEABLE MISUSE event;
 - 2) be able to dissipate the power or energy that may result in NORMAL CONDITION or from the REASONABLY FORESEEABLE MISUSE event;
 - 3) meet the applicable CLEARANCE and CREEPAGE DISTANCE requirements of Annex K for REINFORCED BASIC INSULATION between the terminations of the combination of components.

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

Conformity is checked by inspection and the following test, ~~repeated~~ **performed** three times on the same unit of equipment. 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 ~~maximum~~ **highest** RATED ~~WORKING~~ 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 ~~maximum~~ **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. ~~Any damage to a device used for current limitation shall be ignored if other parts of the equipment were not affected during the test.~~

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

101.3.4 Test leads for the tests of 101.3.2 and 101.3.3

~~Test leads for~~ 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 mm², stranded copper wire;
NOTE 1 A conductor with 16 AWG (American Wire Gauge) cross section is acceptable.
- c) equipment connector compatible with the measuring circuit TERMINALS;
- d) connection to the test voltage source ~~via bare wire~~ into suitable screw TERMINALS or thimble connectors (twist-on wire connectors) or equivalent means of providing a low-impedance connection;
- e) arranged as straight as possible.

NOTE 2 Test leads built to these specifications will have a d.c. resistance of about 15 mΩ each, or 30 mΩ per pair. For the purposes of calculation of possible ~~short-circuit~~ **fault** current in 101.3.2 and 101.3.3, the value of 30 mΩ ~~may~~ **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 μ s, a short-circuit current waveform of 8/20 μ s, 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.

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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 ~~in~~ for circuits not addressed in 6.7, Clauses K.1, K.2 or K.101, and ~~in~~ 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 ~~should~~ shall be considered by the OPERATOR to ensure that they do not exceed the capabilities of the measuring equipment.

NOTE 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 ~~are~~ 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 measuring circuits of
MEASUREMENT CATEGORIES II, III and IV**

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured V	CLEARANCE mm					
	BASIC INSULATION or 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.

NOTE 1 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:

- the a.c. voltage test of 6.8.3.1 with a duration of at least 5 s or the ~~peak~~ 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 ~~for the appropriate line-to-neutral voltage~~;
- the a.c. voltage test of 6.8.3.1 with a duration of at least 1 min or, for ~~d.c.-stressed MAINS~~ 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 ~~for the appropriate line-to-neutral or d.c. voltage~~.

NOTE 2 ~~These two different voltage tests are required for these circuits for the following reasons.~~ 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 ~~a.c.~~ 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 ~~a.c.~~ 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 ~~a.c.~~ 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 ~~a.c.~~ 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 ~~inner~~ insulating layers of printed wiring boards, the requirements of K.101.4.3;
- 4) for thin-film insulation, the requirements of K.101.4.4.

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

K.101.4.2 Moulded and potted parts

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

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

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

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

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

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

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

Conformity is checked by inspection and either by measurement of the ~~part~~ 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 ~~part~~ 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 ~~of~~ through the insulation is at least the applicable value of Table K.9.

Conformity is checked by inspection and either by measurement of the ~~part~~ 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, ~~as applicable for the RATED voltage and MEASUREMENT CATEGORY of the measuring circuit.~~

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

K.102 Reduction of ~~MEASUREMENT CATEGORIES~~ 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:

- Even under SINGLE FAULT CONDITIONS, the circuit shall reduce TRANSIENT OVERVOLTAGES to a lower ~~MEASUREMENT CATEGORY~~ voltage value which depends on the design.
SINGLE FAULT CONDITION includes a short and open circuit of MOV (metal oxide varistor).
- 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 ~~line-to-neutral~~ voltage of the MAINS being measured.

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

Table K.106 – Maximum TRANSIENT OVERVOLTAGES

Line-to-neutral voltage $V_{r.m.s.}$ Nominal a.c. r.m.s. line-to-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
$> 50 \leq 100$	800	1 500	2 500
$> 100 \leq 150$	1 500	2 500	4 000
$> 150 \leq 300$	2 500	4 000	6 000
$> 300 \leq 600$	4 000	6 000	8 000
$> 600 \leq 1 000$	~~4 000~~ 6 000	~~6 000~~ 8 000	~~8 000~~ 12 000
$> 1 000 \leq 1 500$ ^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.			

Annex L
(informative)

Index of defined terms

Add the following term to the list:

MEASUREMENT CATEGORY 3.5.101

Add the following new annexes:

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Annex AA (normative)

Measurement categories

AA.1 General

For the purposes of this document, the following MEASUREMENT CATEGORIES are used. These MEASUREMENT CATEGORIES are not the same as the OVERVOLTAGE CATEGORIES according to ~~IEC 60664-1 Annex K of Part 1~~ and ~~IEC 61010-1 60664-1~~, or the ~~classification of rated impulse withstand voltages~~ (overvoltage categories) according to IEC 60364-4-44.

NOTE MEASUREMENT CATEGORIES are based on locations on the MAINS where measurements may be made.

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

AA.2 MEASUREMENT CATEGORIES

AA.2.1 MEASUREMENT CATEGORY II

MEASUREMENT CATEGORY II is applicable to test and measuring circuits connected directly to utilization points (socket outlets and similar points) of the low-voltage MAINS installation (see Table AA.1 and Figure AA.1). ~~This part of the installation is expected to have a minimum of three levels of overcurrent protective devices between the transformer and the connecting points of the measuring circuit.~~

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

AA.2.2 MEASUREMENT CATEGORY III

MEASUREMENT CATEGORY III is applicable to test and measuring circuits connected to the distribution part of the building's low-voltage MAINS installation (see Table AA.1 and Figure AA.1). ~~This part of the installation is expected to have a minimum of two levels of over-current protective devices between the transformer and possible connecting points.~~

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

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

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

AA.2.3 MEASUREMENT CATEGORY IV

MEASUREMENT CATEGORY IV is applicable to test and measuring circuits connected at the source of the building's low-voltage MAINS installation (see Table AA.1 and Figure AA.1). ~~This part of the installation is expected to have a minimum of one level of over-current protective devices between the transformer and connecting points of the measuring circuit.~~

Due to the high **potential** short-circuit currents ~~which can be followed by a high energy level, measurements made within these locations are extremely dangerous~~ existing in these circuits, any accidental short circuit caused whilst making measurements can create a high energy

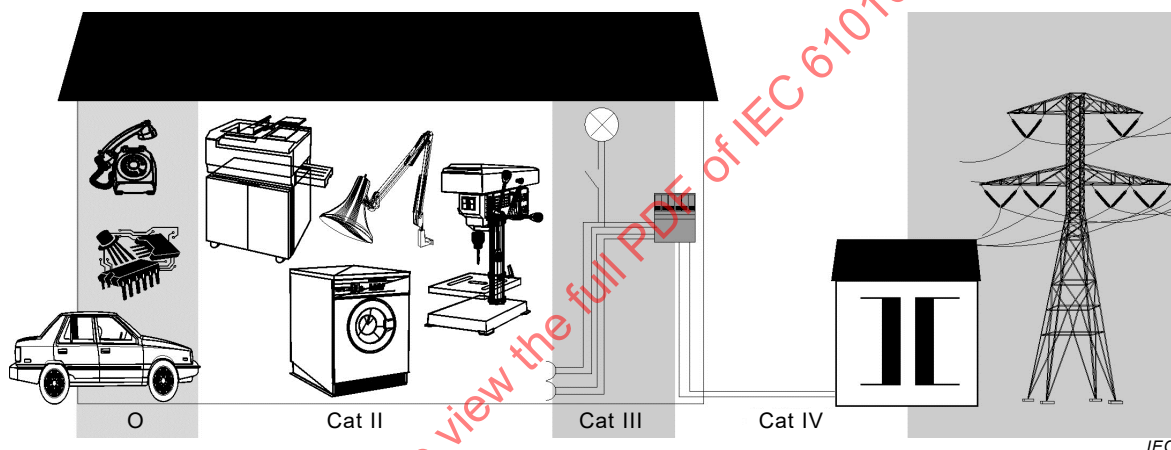
level arc flash which is extremely dangerous to bystanders in the immediate vicinity. Great precautions shall be taken to avoid any chance of a short circuit.

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

AA.2.4 Equipment Measuring circuits without a ~~RATED~~ MEASUREMENT CATEGORY RATING

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

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



Key

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

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

Table AA.1 – Characteristics of MEASUREMENT CATEGORIES

MEASUREMENT CATEGORY	Short-circuit current ^a (typical) kA	Location in the building installation
II	< 10	Circuits connected to MAINS socket outlets and similar points in the MAINS installation
III	< 50	MAINS distribution parts of the buildings
IV	>> 50	Source of the MAINS installation in the building
^a ~~The short-circuit current is calculated for a 1 000 V line-to-neutral voltage and the minimum loop impedance.~~ The values of loop impedances (installation impedances) do not take into account the resistance of the test leads and impedances internal to the measuring equipment. These short-circuit currents vary, depending on the characteristics of the installation.		

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Annex BB (informative)

HAZARDS pertaining to measurements performed in certain environments

BB.1 General

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

BB.2 MAINS circuits

BB.2.1 General

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

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

BB.2.2 Electric shock

MAINS circuits present a HAZARD of electric shock. The voltages and currents are above the permissible ~~limits~~ **levels** (see 6.3), and access to the circuit is usually required to perform the measurement. The manufacturer should provide adequate information to permit the OPERATOR to be aware of the HAZARD of electric shock, and should assure that the design requirements of this Part 2 and other related documents (for example, IEC 61010-031 for voltage probe assemblies) are met.

BB.2.3 Arc ~~flash~~ **blast**

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

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

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

BB.3 Thermal burns

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

BB.4 Telecommunications networks

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

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

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

BB.5 Current measurements in inductive circuits

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

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

BB.6 Battery-driven circuits

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

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

BB.7 Measurements at higher frequencies

Some measuring equipment depends on inductive connection to the circuit being measured. See IEC 61010-2-032 for examples of some current probes that use inductive connections.

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

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

BB.8 Measurements using measuring circuits with a FUNCTIONAL EARTH TERMINAL

Oscilloscopes and spectrum analysers are examples of equipment that often include FUNCTIONAL EARTH TERMINALS in the measuring circuit. A case of REASONABLY FORESEEABLE MISUSE is when the OPERATOR might 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 should inadvertently connect the FUNCTIONAL EARTH TERMINAL to a HAZARDOUS LIVE VOLTAGE, then the chassis of the measuring equipment could also be connected to the HAZARDOUS LIVE VOLTAGE, and the OPERATOR or a bystander could receive an electric shock from the chassis.

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Annex CC (informative)

4 mm “banana” TERMINALS

CC.1 General

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

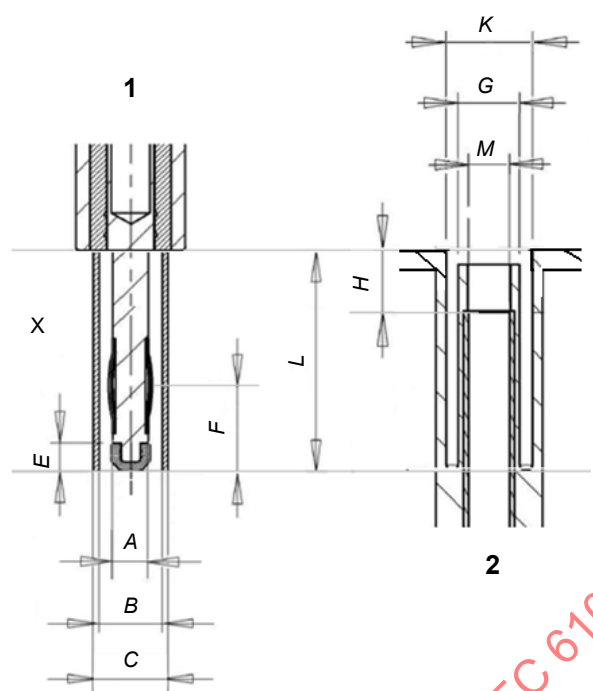
Annex CC gives the recommended dimensions for safety purposes of 4 mm TERMINALS when probe assemblies complying with IEC 61010-031:2015, Annex E, can be connected. These 4 mm TERMINALS are often called “banana connectors”.

CC.2 Dimensions

The dimensions of Figure CC.1 are compatible with requirements for TERMINALS of MEASUREMENT CATEGORIES II, III or IV up to 1 000 V.

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

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



IEC

Key $A = 3,90 \text{ mm} \pm 0,05 \text{ mm}$ (compressed) $B \geq 6,6 \text{ mm}$ $C \leq 7,9 \text{ mm}$ $2,6 \text{ mm} \leq E \leq 6 \text{ mm}$ $F \leq 12 \text{ mm}$ $M = 4,00 \text{ mm} \pm 0,05 \text{ mm}$ $G \leq 6,4 \text{ mm}$ $K \geq 8,1 \text{ mm}$ $4 \text{ mm} \leq H \leq 6 \text{ mm}$ $L \geq 20 \text{ mm}$ Tolerances on dimensions without specific tolerances: $\pm 0,1 \text{ mm}$

- 1 is a male TERMINAL
- 2 is a female TERMINAL
- X is the point where the best contact occurs
- A is the maximum diameter where the contact occurs
- minimum value of E and H depends of the presence of plastic parts. CLEARANCES shall be at least 2,6 mm.

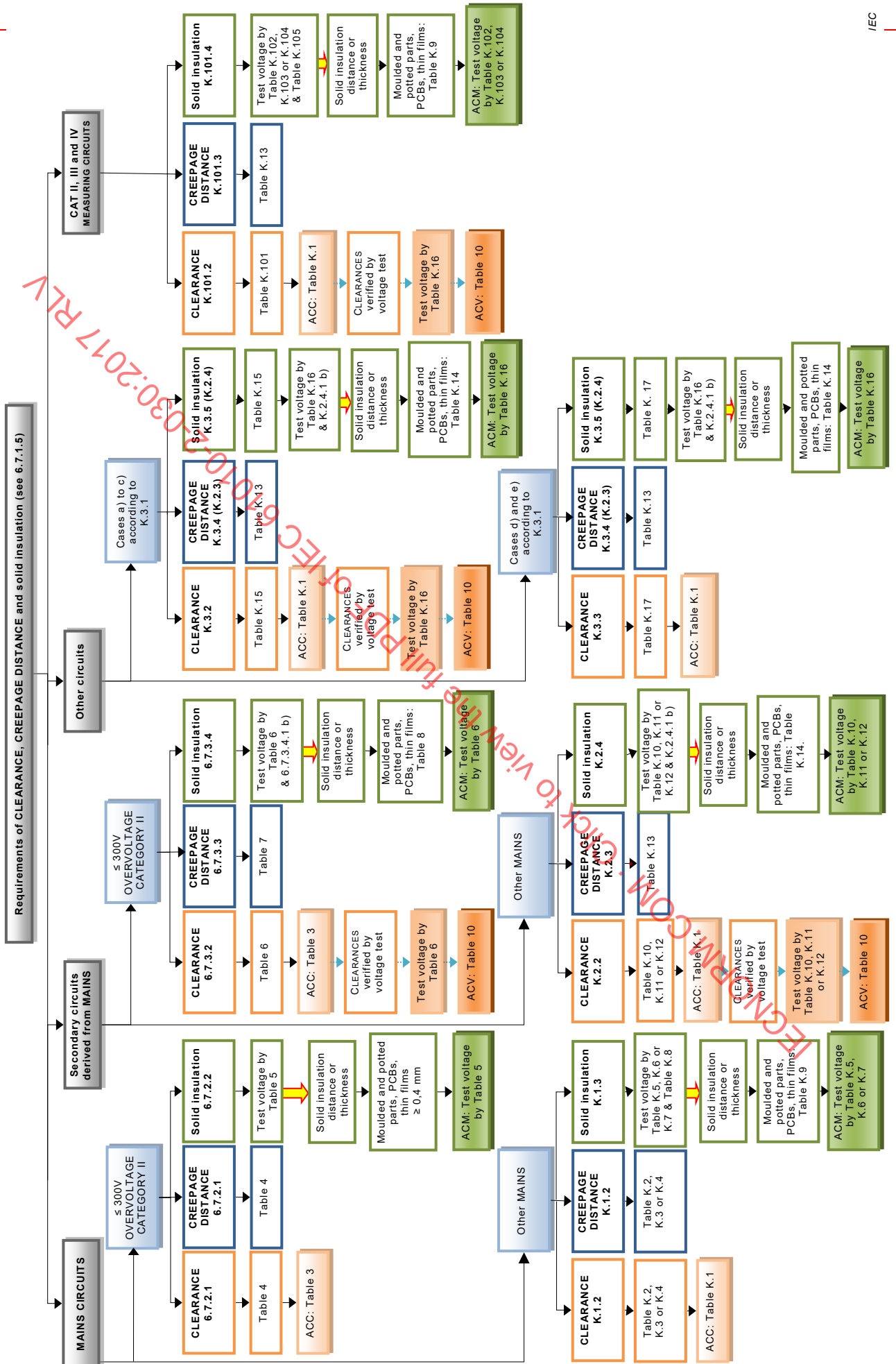
Figure CC.1 – Recommended dimensions of 4 mm TERMINALS

Annex DD (informative)

Flowchart for insulation according to the type of circuit

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

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Key	
ACC	Rated altitude correction of CLEARANCE
ACV	Site altitude correction of test voltage
&	Both required
ACM	Alternate conformity means
▶	As applicable
⇅	Optional test path

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

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Bibliography

The Bibliography of Part 1 is applicable except as follows.

Deletion:

Delete the following reference:

IEC 61010-2-030, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Special requirements for testing and measuring circuits*

Addition:

Add the following new references:

IEC TS 60479-1:2005, *Effects of current on human beings and livestock – Part 1: General aspects*

IEC TS 60479-2:2007, *Effects of current on human beings and livestock – Part 2: Special aspects*

~~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*~~

IEC 61010-2-033, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-033: Particular requirements for HAND-HELD MULTIMETERS and other METERS, for domestic and professional use, capable of measuring MAINS voltage*

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

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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**

**Exigences de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire –
Partie 2-030: Exigences particulières pour les appareils équipés de circuits d'essai ou de mesure**

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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

FOREWORD

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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 Tables K.102 to 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.

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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*

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.

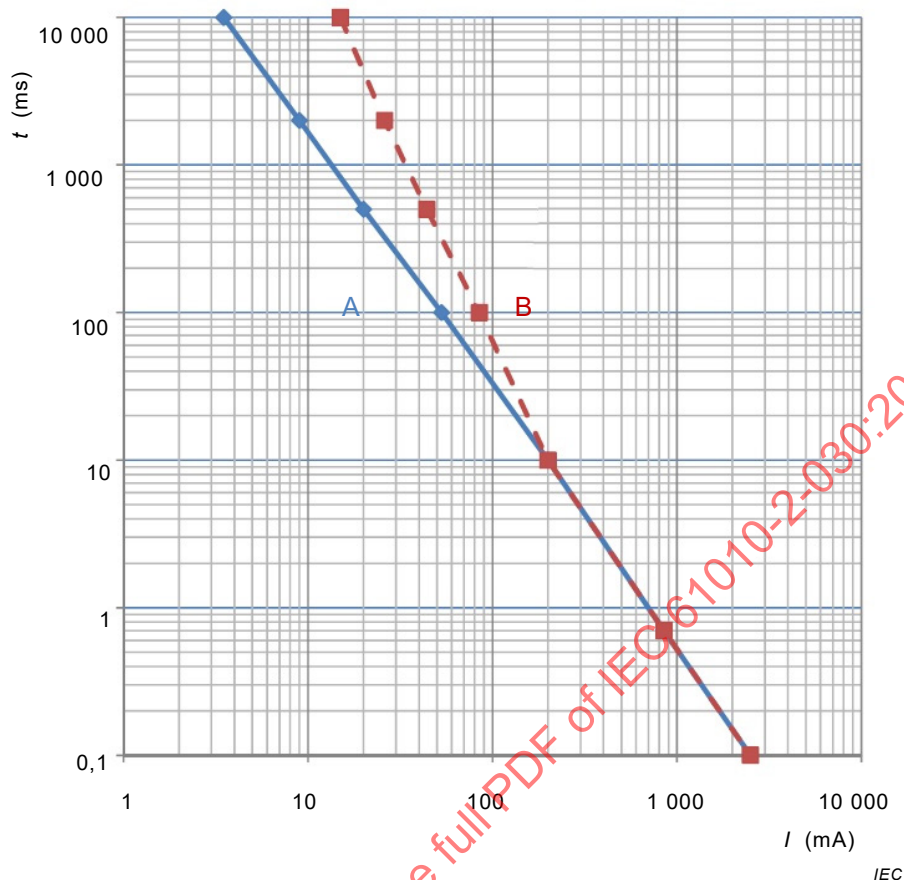
Conformity is checked by connecting the ACCESSIBLE conductive parts to the maximum HAZARDOUS LIVE voltage according to the equipment RATINGS while the equipment is operated in NORMAL USE. The current between the ACCESSIBLE conductive parts and the PROTECTIVE CONDUCTOR TERMINAL is measured with the circuit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

- 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),
- 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 D_2 in Table K.15. For homogeneous fields, a lower CLEARANCE value can be achieved by testing (see IEC 60664-1 for more information about homogeneous fields).

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:

- highest RATED a.c. voltage at any RATED MAINS frequency;*
- highest RATED d.c. voltage;*
- 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 μ s, a short-circuit current waveform of 8/20 μ s, 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.

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

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

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

101.3.4 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 mm², stranded copper wire;
NOTE 1 A conductor with 16 AWG (American Wire Gauge) cross section is acceptable.
- c) equipment connector compatible with the measuring circuit TERMINALS;

- d) connection to the test voltage source 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 m Ω each, or 30 m Ω per pair. For the purposes of calculation of possible fault current in 101.3.2 and 101.3.3, the value of 30 m Ω 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 μ s, a short-circuit current waveform of 8/20 μ s, 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.

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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 measuring circuits of MEASUREMENT CATEGORIES II, III and IV

Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured 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:

- 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;
- 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. line-to-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.			

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Annex L
(informative)

Index of defined terms

Add the following term to the list:

MEASUREMENT CATEGORY 3.5.101

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Add the following new annexes:

Annex AA (normative)

MEASUREMENT CATEGORIES

AA.1 General

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

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

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

AA.2 MEASUREMENT CATEGORIES

AA.2.1 MEASUREMENT CATEGORY II

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

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

AA.2.2 MEASUREMENT CATEGORY III

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

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

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

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

AA.2.3 MEASUREMENT CATEGORY IV

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

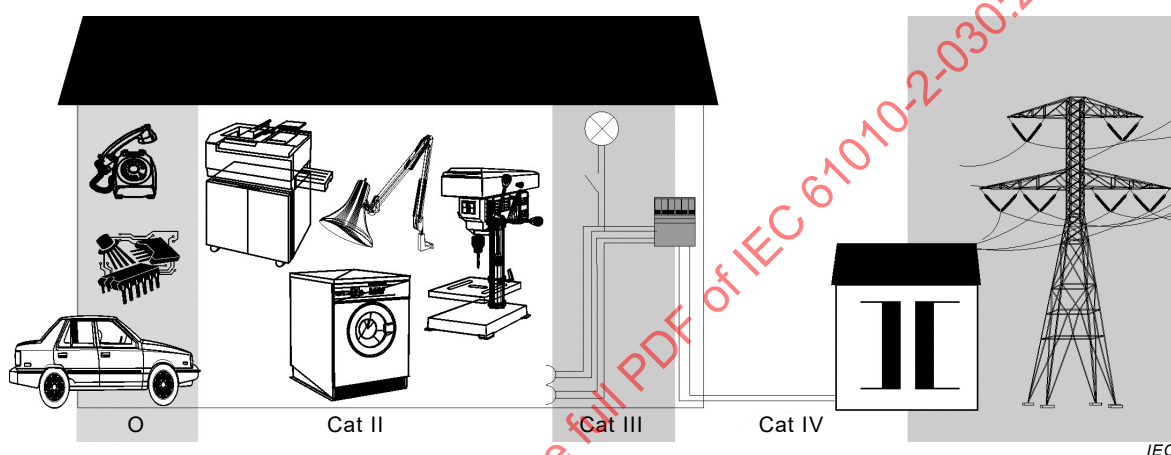
Due to the high potential short-circuit currents existing in these circuits, any accidental short circuit caused whilst making measurements can create a high energy level arc flash which is extremely dangerous to bystanders in the immediate vicinity. Great precautions shall be taken to avoid any chance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

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

AA.2.4 Measuring circuits without a MEASUREMENT CATEGORY RATING

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

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



Key

- O Measuring circuits without a MEASUREMENT CATEGORY
- CAT II MEASUREMENT CATEGORY II
- CAT III MEASUREMENT CATEGORY III
- CAT IV MEASUREMENT CATEGORY IV

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

Table AA.1 – Characteristics of MEASUREMENT CATEGORIES

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

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

Annex BB (informative)

HAZARDS pertaining to measurements performed in certain environments

BB.1 General

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

BB.2 MAINS circuits

BB.2.1 General

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

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

BB.2.2 Electric shock

MAINS circuits present a HAZARD of electric shock. The voltages and currents are above the permissible levels (see 6.3), and access to the circuit is usually required to perform the measurement. The manufacturer should provide adequate information to permit the OPERATOR to be aware of the HAZARD of electric shock, and should assure that the design requirements of this Part 2 and other related documents (for example, IEC 61010-031 for voltage probe assemblies) are met.

BB.2.3 Arc blast

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

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

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

BB.3 Thermal burns

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

BB.4 Telecommunications networks

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

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

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

BB.5 Current measurements in inductive circuits

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

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

BB.6 Battery-driven circuits

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

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

BB.7 Measurements at higher frequencies

Some measuring equipment depends on inductive connection to the circuit being measured. See IEC 61010-2-032 for examples of some current probes that use inductive connections.

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

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

BB.8 Measurements using measuring circuits with a FUNCTIONAL EARTH TERMINAL

Oscilloscopes and spectrum analysers are examples of equipment that often include FUNCTIONAL EARTH TERMINALS in the measuring circuit. A case of REASONABLY FORESEEABLE MISUSE is when the OPERATOR might 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 should inadvertently connect the FUNCTIONAL EARTH TERMINAL to a HAZARDOUS LIVE VOLTAGE, then the chassis of the measuring equipment could also be connected to the HAZARDOUS LIVE VOLTAGE, and the OPERATOR or a bystander could receive an electric shock from the chassis.

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Annex CC (informative)

4 mm “banana” TERMINALS

CC.1 General

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

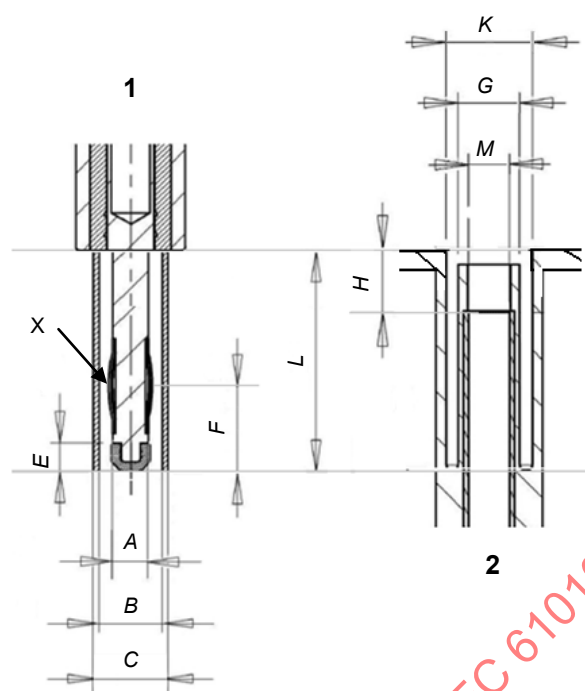
Annex CC gives the recommended dimensions for safety purposes of 4 mm TERMINALS when probe assemblies complying with IEC 61010-031:2015, Annex E, can be connected. These 4 mm TERMINALS are often called “banana connectors”.

CC.2 Dimensions

The dimensions of Figure CC.1 are compatible with requirements for TERMINALS of MEASUREMENT CATEGORIES II, III or IV up to 1 000 V.

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

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

**Key**

$A = 3,90 \text{ mm} \pm 0,05 \text{ mm}$ (compressed)

$B \geq 6,6 \text{ mm}$

$C \leq 7,9 \text{ mm}$

$2,6 \text{ mm} \leq E \leq 6 \text{ mm}$

$F \leq 12 \text{ mm}$

$M = 4,00 \text{ mm} + 0,05 \text{ mm}$

$G \leq 6,4 \text{ mm}$

$K \geq 8,1 \text{ mm}$

$4 \text{ mm} \leq H \leq 6 \text{ mm}$

$L \geq 20 \text{ mm}$

Tolerances on dimensions without specific tolerances: $\pm 0,1 \text{ mm}$

- 1 is a male TERMINAL
- 2 is a female TERMINAL
- X is the point where the best contact occurs
- A is the maximum diameter where the contact occurs
- minimum value of E and H depends of the presence of plastic parts. CLEARANCES shall be at least 2,6 mm.

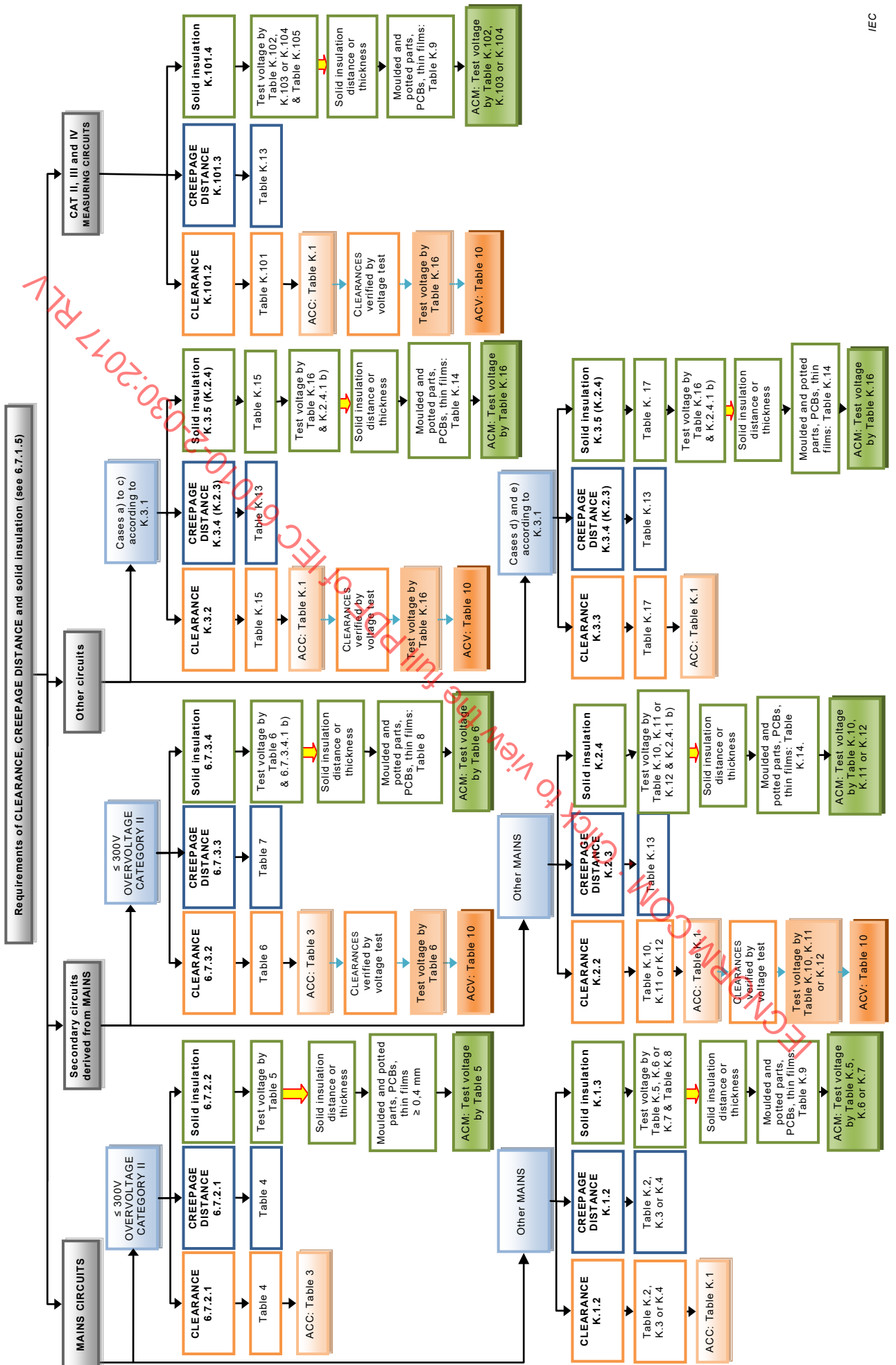
Figure CC.1 – Recommended dimensions of 4 mm TERMINALS

Annex DD (informative)

Flowchart for insulation according to the type of circuit

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

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Key	
ACC	Rated altitude correction of CLEARANCE
ACV	Site altitude correction of test voltage
&	Both required
ACM	Alternate conformity means
▶	As applicable
⇓	Optional test path

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

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Bibliography

The Bibliography of Part 1 is applicable except as follows.

Deletion:

Delete the following reference:

IEC 61010-2-030, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Special requirements for testing and measuring circuits*

Addition:

Add the following new references:

IEC TS 60479-1:2005, *Effects of current on human beings and livestock – Part 1: General aspects*

IEC TS 60479-2:2007, *Effects of current on human beings and livestock – Part 2: Special aspects*

IEC 61010-2-033, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-033: Particular requirements for HAND-HELD MULTIMETERS and other METERS, for domestic and professional use, capable of measuring MAINS voltage*

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

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

EXIGENCES DE SÉCURITÉ POUR APPAREILS ÉLECTRIQUES DE MESURAGE, DE RÉGULATION ET DE LABORATOIRE –

Partie 2-030: Exigences particulières pour les appareils équipés de circuits d'essai ou de mesure

AVANT-PROPOS

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- 9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

La Norme internationale IEC 61010-2-030 a été établie par le comité d'études 66 de l'IEC: Sécurité des appareils de mesure, de commande et de laboratoire.

Elle a le statut d'une publication groupée de sécurité conformément au Guide IEC 104.

Cette deuxième édition annule et remplace la première édition parue en 2010. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) Une référence à l'IEC 61010-031 pour les sondes équipées et à l'IEC 61010-2-032 pour les capteurs de courant a été ajoutée.
- b) La liaison indirecte pour les circuits d'essai et de mesure a été modifiée, notamment pour prendre en compte la durée de l'écoulement du courant par rapport au courant passant par le corps pour le courant alternatif et le courant continu conformément à l'IEC TS 60479-1 et l'IEC TS 60479-2.
- c) Des LIGNES DE FUITE et DISTANCES D'ISOLEMENT pour les EMPLACEMENTS HUMIDES et pour la BORNE du circuit de mesure de tension supérieure à 1000 V en courant alternatif ou en courant continu ont été spécifiées.
- d) La source de tension pour les essais du composant ou du circuit de limitation des surtensions peut être limitée à 400 V.
- e) Des exigences relatives aux SURTENSIONS TRANSITOIRES applicables aux circuits de mesure de la tension RESEAU ont été ajoutées.
- f) Des exigences applicables aux circuits de mesure entre 1 000 V et 1 500 V en courant continu ont été ajoutées.
- g) Le corrigendum a été inclus dans les Tableaux K.102 à K.104.
- h) Les exigences applicables à la réduction des SURTENSIONS TRANSITOIRES ont été modifiées.
- i) Une Annexe CC informative relative aux dimensions des BORNES «banane» a été ajoutée.
- j) Un organigramme de l'isolation selon le type de circuit a été ajouté dans une nouvelle Annexe DD.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
66/613/FDIS	66/621/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

La présente Partie 2-030 doit être utilisée conjointement avec la dernière édition de l'IEC 61010-1. Elle a été établie sur la base de la troisième édition (2010) de l'IEC 61010-1, y compris son amendement 1 (2016).

La présente Partie 2-030 complète ou modifie les articles correspondants de l'IEC 61010-1 de façon à la transformer en norme IEC: *Exigences particulières pour les appareils équipés de circuits d'essai ou de mesure.*

Lorsqu'un paragraphe particulier de la Partie 1 n'est pas mentionné dans la présente partie 2, ce paragraphe s'applique pour autant qu'il est raisonnable. Lorsque la présente partie spécifie "addition", "modification", "remplacement" ou "suppression", il convient d'adapter en conséquence l'exigence, la modalité d'essai ou la note correspondante de la Partie 1.

Dans la présente norme:

- a) les caractères d'imprimerie suivants sont employés:
 - exigences: caractères romains;
 - NOTES: petits caractères romains;
 - *conformité et essai: caractères italiques;*
 - termes définis à l'Article 3 et utilisés tout au long de la présente norme: PETITES CAPITALES EN CARACTÈRES ROMAINS;

- b) les paragraphes, figures, tableaux et notes complémentaires à ceux de la Partie 1 sont numérotés à partir de 101. Les annexes complémentaires sont nommées à partir de AA et les listes de termes additionnels à partir de aa).

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 61010, publiées sous le titre général *Exigences de sécurité pour appareils électriques de mesure, de régulation et de laboratoire*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "<http://webstore.iec.ch>" dans les données relatives à la publication recherchée. À cette date, la publication sera

- reconduite,
- supprimée,
- remplacée par une édition révisée, ou
- amendée.

IMPORTANT – Le logo "colour inside" qui se trouve sur la page de couverture de cette publication indique qu'elle contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer cette publication en utilisant une imprimante couleur.

INTRODUCTION

L'IEC 61010-1 spécifie les exigences de sécurité qui sont d'application générale à tous les appareils qu'elle concerne. Pour certains types d'appareils, les exigences de l'IEC 61010-1 et son amendement sont complétées ou modifiées par les exigences particulières d'une ou de plusieurs Parties 2 particulières de la norme, qui sont utilisées conjointement avec les exigences de la Partie 1.

La présente Partie 2-030 spécifie les exigences de sécurité pour les appareils équipés de circuits d'essai ou de mesure qui sont reliés à des fins d'essai ou de mesurage à des dispositifs ou à des circuits extérieurs à l'appareil de mesure même.

La Partie 2-032 spécifie les exigences de sécurité applicables aux capteurs de courant PORTATIFS et manipulés à la main (voir l'Article 1 de la Partie 2-032). Les exigences de la Partie 2-030 ont été incluses dans la Partie 2-032. Les appareils relevant des domaines d'application des Parties 2-030 et 2-032 sont considérés comme étant couverts par les exigences de la Partie 2-032.

La Partie 2-033 spécifie les exigences de sécurité pour les MULTIMETRES PORTATIFS et autres MESUREURS qui ont pour objectif principal de mesurer la tension d'un RESEAU sous tension. Les exigences de la Partie 2-030 ont été incluses dans la Partie 2-033. Les pièces des appareils relevant des domaines d'application des Parties 2-030 et 2-033 sont considérées comme étant couvertes par les exigences de la Partie 2-033.

La Partie 2-034 spécifie les exigences de sécurité applicables aux appareils de mesure de la résistance d'isolement et aux appareils d'essai de rigidité diélectrique qui sont connectés aux unités, aux lignes ou aux circuits à des fins d'essai ou de mesurage. Les exigences de la Partie 2-030 ont été incluses dans la Partie 2-034. Les appareils relevant des domaines d'application des Parties 2-030 et 2-034 sont considérés comme étant couverts par les exigences de la Partie 2-034.

Cependant, pour les appareils relevant des domaines d'application des Parties 2-032, 2-033 et 2-034, les normes sont utilisées conjointement.

EXIGENCES DE SÉCURITÉ POUR APPAREILS ÉLECTRIQUES DE MESURAGE, DE RÉGULATION ET DE LABORATOIRE –

Partie 2-030: Exigences particulières pour les appareils équipés de circuits d'essai ou de mesure

1 Domaine d'application et objet

L'article de la Partie 1 est applicable à l'exception de ce qui suit:

1.1.1 Appareils inclus dans le domaine d'application

Remplacement:

Remplacer le texte par ce qui suit:

La présente publication groupée de sécurité est avant tout destinée à être utilisée en tant que norme en matière de sécurité des produits pour les produits cités dans le domaine d'application. Elle doit également être utilisée par les comités d'études dans le cadre de l'élaboration de leurs publications pour des produits similaires à ceux cités dans le domaine d'application de la présente norme, conformément aux principes établis dans le Guide IEC 104 et le Guide ISO/IEC 51.

La présente partie de l'IEC 61010 spécifie les exigences de sécurité pour les appareils équipés de circuits d'essai ou de mesure qui sont reliés à des fins d'essai ou de mesurage à des dispositifs ou à des circuits extérieurs à l'appareil de mesure.

Ceux-ci comprennent les circuits de mesure qui font partie d'appareils électriques d'essai et de mesure, d'appareils de laboratoire ou d'appareils de contrôle de processus. L'existence de ces circuits dans l'appareil exige des moyens de protection additionnels entre le circuit et un OPERATEUR.

NOTE Ces circuits d'essai et de mesure peuvent, par exemple:

- mesurer des tensions sur des circuits d'autres matériels,
- mesurer la température d'un dispositif séparé par l'intermédiaire d'un thermocouple,
- mesurer la force d'un dispositif séparé avec une jauge de contrainte,
- injecter une tension sur un circuit pour analyser un nouveau montage.

Les appareils équipés de ces circuits d'essai et de mesure peuvent être destinés à effectuer des essais et des mesurages sur des conducteurs dangereux, y compris des conducteurs du RESEAU et des conducteurs de réseaux de télécommunication. Voir l'Annexe BB sur les DANGERS encourus lors de divers essais et mesurages.

2 Références normatives

L'article de la Partie 1 est applicable à l'exception de ce qui suit:

Remplacement:

Remplacer

IEC 60364-4-44, *Installations électriques à basse tension – Partie 4-44: Protection pour assurer la sécurité – Protection contre les perturbations de tension et les perturbations électromagnétiques*

par la nouvelle référence suivante:

IEC 60364-4-44, *Installations électriques à basse tension – Partie 4-44: Protection pour assurer la sécurité – Protection contre les perturbations de tension et les perturbations électromagnétiques*
IEC 60364-4-44:2007/AMD1:2015

Addition:

Ajouter la nouvelle référence normative suivante:

IEC 61010-2-032, *Règles de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire – Partie 2-032: Exigences particulières pour les capteurs de courant, portatifs et manipulés à la main, de test et de mesure électriques*

3 Termes et définitions

L'article de la Partie 1 est applicable à l'exception de ce qui suit:

3.5 Termes de sécurité

Remplacement:

Remplacer la définition de 3.5.4 par la nouvelle définition suivante:

3.5.4

RESEAU

alimentation électrique basse tension

Addition:

Ajouter la nouvelle définition suivante:

3.5.101

CATEGORIE DE MESURE

classification des circuits d'essai et de mesure selon le type de RESEAUX auxquels ils sont prévus d'être reliés

Note 1 à l'article: Les CATEGORIES DE MESURE tiennent compte des CATEGORIES DE SURTENSION, des niveaux des courants de court-circuit, de l'endroit de l'installation du bâtiment où l'essai ou le mesurage doit être réalisé et de certaines dispositions de limitation de l'énergie ou de protection contre les transitoires de l'installation du bâtiment. Voir l'Annexe AA pour de plus amples informations.

4 Essais

L'article de la Partie 1 est applicable.

5 Marquage et documentation

L'article de la Partie 1 est applicable à l'exception de ce qui suit:

5.1.5 BORNES, connexions et dispositifs de manœuvre

Addition:

Ajouter le nouveau paragraphe suivant:

5.1.5.101 BORNES des circuits de mesure

5.1.5.101.1 Généralités

Sauf si autorisé par 5.1.5.101.4:

- a) la valeur de la tension ASSIGNEE par rapport à la terre des BORNES des circuits de mesure doit être marquée, et
- b) la valeur de la tension ASSIGNEE ou du courant ASSIGNE, selon le cas, de chaque paire ou jeu de BORNES des circuits de mesure prévus pour être utilisés ensemble doit être marquée, et
- c) la CATEGORIE DE MESURE appropriée de chaque paire individuelle ou jeu de BORNES des circuits de mesure, ou le symbole 14 du Tableau 1, doit être marqué(e) selon les spécifications de 5.1.5.101.2 et 5.1.5.101.3, le cas échéant.

Les BORNES des circuits de mesure sont habituellement associées par paires ou jeux. Chaque paire ou jeu de BORNES peut avoir une tension ASSIGNEE ou un courant ASSIGNE, ou les deux, au sein de ce jeu, et chaque BORNE peut avoir individuellement une tension ASSIGNEE par rapport à la terre. Pour certains appareils, la tension ASSIGNEE entre les BORNES peut être différente de la tension ASSIGNEE par rapport à la terre. Les marquages doivent être clairs pour éviter toute confusion.

Le symbole 14 du Tableau 1 doit être apposé lorsque les BORNES des circuits de mesure de courant ne sont pas prévues pour être connectées à des transformateurs de courant sans protection interne (voir 101.2).

Les marquages doivent être placés près des BORNES. Cependant, s'il n'y a pas suffisamment de place (comme sur les appareils à entrées multiples), le marquage peut être placé sur la plaque SIGNALÉTIQUE ou sur le cadran, ou le symbole 14 du Tableau 1 peut être apposé près de la BORNE.

Lorsque le symbole 14 du Tableau 1 est proche de plusieurs jeux de BORNES des circuits de mesure, il n'est pas nécessaire de l'apposer plus d'une fois.

La conformité est vérifiée par examen et, le cas échéant, comme spécifié par 5.1.5.101.2 et 5.1.5.101.3, en tenant compte des exceptions de 5.1.5.101.4.

5.1.5.101.2 BORNES des circuits de mesure ASSIGNEES pour les CATEGORIES DE MESURE II, III ou IV

La CATEGORIE DE MESURE appropriée doit être marquée pour les BORNES des circuits de mesure ASSIGNEES pour les mesurages dans les CATEGORIES DE MESURE II, III ou IV. Le marquage de la CATEGORIE DE MESURE doit être "CAT II", "CAT III" ou "CAT IV" selon ce qui est applicable.

Le marquage de plus d'une CATEGORIE DE MESURE et sa tension ASSIGNEE par rapport à la terre est autorisé.

La conformité est vérifiée par examen.

5.1.5.101.3 BORNES des circuits de mesure ASSIGNEES pour la connexion à des tensions supérieures aux niveaux de 6.3.1

Le symbole 14 du Tableau 1 doit être apposé pour les BORNES des circuits de mesure ASSIGNEES pour la connexion à des tensions supérieures aux niveaux de 6.3.1, mais non ASSIGNEES pour les mesurages dans les CATEGORIES DE MESURE II, III ou IV (voir aussi 5.4.1 bb)).

La conformité est vérifiée par examen.

5.1.5.101.4 BORNES des circuits de mesure connectées en permanence, spécifiques ou à basse tension

Il n'est pas nécessaire d'apposer un marquage pour les BORNES des circuits de mesure si:

- a) elles sont prévues pour être en permanence connectées et non ACCESSIBLES (voir 5.4.3 aa) et bb)), ou
- b) elles sont prévues pour être connectées uniquement à des BORNES spécifiques d'autres appareils, ou
- c) il est évident, par d'autres indications, que la tension ASSIGNEE est inférieure aux niveaux de 6.3.1.

NOTE Exemples d'indications autorisées mentionnant que les entrées sont prévues pour être inférieures aux niveaux de 6.3.1:

- l'indication de l'échelle totale balayée par l'aiguille d'un voltmètre ou d'un ampèremètre avec une seule plage ou l'indication maximale d'un multimètre avec plusieurs plages;
- l'indication de l'échelle maximale portée sur un sélecteur de tension;
- une tension ou une puissance ASSIGNEE exprimée en dB, mW ou W et dont la valeur équivalente décrite dans la documentation est inférieure à 30 V en courant alternatif.

La conformité est vérifiée par examen.

5.4.1 Généralités

Addition:

Ajouter les nouveaux points suivants à la liste ainsi qu'un nouvel alinéa:

- aa) des informations sur chaque CATEGORIE DE MESURE appropriée si la CATEGORIE DE MESURE II, III ou IV est une CARACTERISTIQUE ASSIGNEE du circuit de mesure (voir 5.1.5.101.2);
- bb) les CARACTERISTIQUES ASSIGNEES détaillées, y compris le niveau des SURTENSIONS TRANSITOIRES, et un avertissement de ne pas utiliser l'appareil pour des mesurages sur le RESEAU, si les CATEGORIES DE MESURE II, III ou IV ne sont pas des CARACTERISTIQUES ASSIGNEES des circuits de mesure et si ces circuits de mesure peuvent être connectés par mégarde sur des circuits RESEAU (voir AA.2.4 pour de plus amples informations).

Certains appareils peuvent avoir plusieurs CATEGORIES DE MESURE ASSIGNEES pour un même circuit de mesure. Pour de tels appareils, la documentation doit identifier clairement les CATEGORIES DE MESURE pour lesquelles il est prévu d'utiliser l'appareil et celles pour lesquelles l'appareil ne doit pas être utilisé.

5.4.3 Installation des appareils

Addition:

Ajouter les deux nouveaux points suivants à la liste:

- aa) pour les BORNES des circuits de mesure prévues pour être connectées en permanence et dont la CATEGORIE DE MESURE II, III ou IV est une CARACTERISTIQUE ASSIGNEE, les

informations sur la CATEGORIE DE MESURE, les tensions ASSIGNEES ou les courants ASSIGNES, selon ce qui est applicable (voir 5.1.5.101.2);

- bb) pour les BORNES des circuits de mesure prévues pour être connectées en permanence et dont la CATEGORIE DE MESURE II, III ou IV n'est pas une CARACTERISTIQUE ASSIGNEE, les informations sur les valeurs ASSIGNEES de la tension, du courant et des SURTENSIONS TRANSITOIRES, selon ce qui est applicable (voir 5.1.5.101.4).

6 Protection contre les chocs électriques

L'article de la Partie 1 est applicable à l'exception de ce qui suit:

6.1.2 Exceptions

Ajouter le nouveau point suivant à la liste:

- aa) BORNES de mesure de type verrouillable ou à vis, y compris les BORNES qui n'exigent pas l'utilisation d'un OUTIL.

6.5.2.1 Généralités

Remplacement:

Remplacer la déclaration de conformité par ce qui suit:

La conformité est vérifiée comme spécifié de 6.5.2.2 à 6.5.2.6 et en 6.5.2.101.

6.5.2.3 BORNE DE TERRE DE PROTECTION

Remplacement:

Remplacer le point h) 2) par le suivant:

- h) 2) la LIAISON DE PROTECTION ne doit pas être interrompue par la présence de tout interrupteur ou commutateur. Les dispositifs utilisés pour une liaison indirecte dans les circuits d'essai et de mesure (voir 6.5.2.101) sont autorisés à faire partie de la LIAISON DE PROTECTION.

Addition:

Ajouter le nouveau paragraphe suivant ainsi que la nouvelle figure suivante:

6.5.2.101 Liaison indirecte pour les circuits d'essai et de mesure

La liaison indirecte établit une connexion entre la BORNE DE TERRE DE PROTECTION et les parties conductrices ACCESSIBLES lorsqu'elles deviennent SOUS TENSION DANGEREUSE par suite d'un défaut.

Les dispositifs pouvant établir cette liaison indirecte sont les suivants:

- a) Les dispositifs limiteurs de tension qui deviennent conducteurs quand la tension qu'ils détectent est supérieure aux niveaux appropriés de 6.3.2 a), avec une protection contre les surintensités pour éviter le claquage du dispositif. La durée par rapport au courant ne doit pas dépasser les niveaux de la Figure 101.

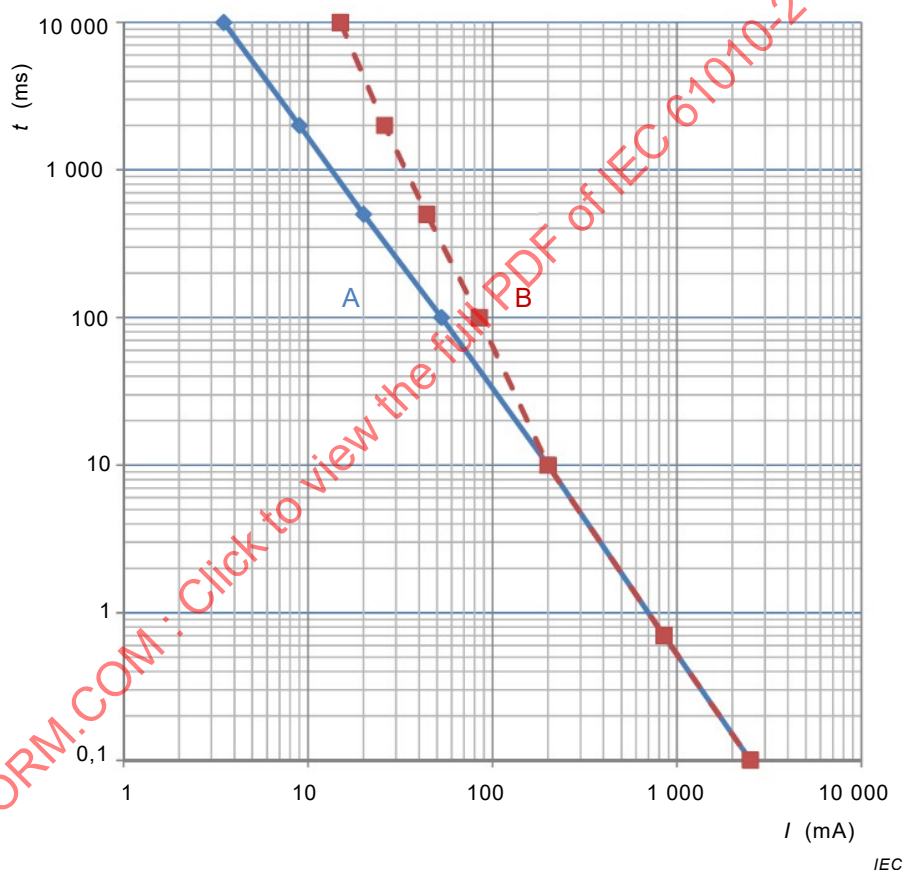
La conformité est vérifiée en connectant les parties conductrices ACCESSIBLES à la tension ACTIVE DANGEREUSE maximale selon les CARACTERISTIQUES ASSIGNEES de l'appareil tandis que celui-ci fonctionne en UTILISATION NORMALE. Le courant entre les parties conductrices ACCESSIBLES et la BORNE DE TERRE DE PROTECTION est mesuré à l'aide du circuit de la Figure A.1.

- b) Les dispositifs de déclenchement sensibles à la tension qui coupent toutes les phases de l'alimentation RESEAU ou la source de tension ACTIVE DANGEREUSE, et connectent les parties conductrices ACCESSIBLES à la BORNE DE TERRE DE PROTECTION quand la tension qu'ils détectent atteint les niveaux appropriés de 6.3.2 a). La durée du déclenchement par rapport au courant ne doit pas dépasser les niveaux de la Figure 101.

La conformité est vérifiée en appliquant successivement le niveau approprié de tension de 6.3.2 a) et la tension ASSIGNEE maximale entre les parties conductrices ACCESSIBLES et la BORNE DE TERRE DE PROTECTION. Le courant entre les parties conductrices ACCESSIBLES et la BORNE DE TERRE DE PROTECTION est mesuré à l'aide du circuit de la Figure A.1.

Les dispositifs limiteurs de tension ou les dispositifs de déclenchement sensibles à la tension tels que définis en a) et b) doivent avoir au minimum les valeurs ASSIGNEES de tension et de courant des BORNES des circuits de mesure.

La conformité est vérifiée par examen.



Légende

- A Courant alternatif (mA)
B Courant continu (mA)

NOTE La présente Figure est basée sur l'IEC TS 60479-1:2005, Figures 20 et 22 et sur l'IEC TS 60479-2:2007, Figure 20.

Figure 101 – Durée de l'écoulement du courant par rapport au courant passant par le corps pour les courants alternatif et continu

6.6 Connexions aux circuits extérieurs

Addition:

Ajouter les nouveaux paragraphes suivants:

6.6.101 BORNES des circuits de mesure

Les parties conductrices de chaque BORNE non branchée d'un circuit de mesure qui peuvent devenir SOUS TENSION DANGEREUSE lorsque la tension maximale ASSIGNEE est appliquée aux autres BORNES du circuit de mesure de l'appareil doivent être séparées:

- de la partie la plus proche du doigt d'épreuve touchant les parties extérieures de cette BORNE dans la position la plus défavorable, par au moins la DISTANCE D'ISOLEMENT et la LIGNE DE FUITE applicables du Tableau 101 pour les BORNES ayant une tension ASSIGNEE pouvant atteindre 1 000 V en courant alternatif ou 1 500 V en courant continu (voir Figure 1),
- de la partie la plus proche du doigt d'épreuve touchant les parties extérieures de cette BORNE dans la position la plus défavorable, par au moins 2,8 mm pour la DISTANCE D'ISOLEMENT et la LIGNE DE FUITE pour les BORNES ayant une tension ASSIGNEE supérieure à 1 000 V en courant alternatif ou 1 500 V en courant continu.

De plus, les BORNES ayant une tension ASSIGNEE supérieure à 1 000 V en courant alternatif ou 1 500 V en courant continu doivent résister à l'essai de tension de 6.8 avec une tension d'essai égale à la tension ASSIGNEE de la BORNE multipliée par 1,25 appliquée entre la partie la plus proche du doigt d'épreuve touchant les parties extérieures de la BORNE dans la position la plus défavorable et les autres BORNES du circuit de mesure.

EXEMPLE Pour une tension ASSIGNEE efficace de 4 000 V, la valeur efficace de la tension d'essai est de 5 000 V (valeur crête de 7 070 V). La distance d'isolement calculée est de 13,1 mm conformément au D_2 du Tableau K.15. Pour les champs homogènes, une DISTANCE D'ISOLEMENT moins élevée peut être obtenue au moyen d'essais (voir l'IEC 60664-1 pour de plus amples informations sur les champs homogènes).

Tableau 101 – DISTANCES D'ISOLEMENT et LIGNES DE FUITE des BORNES d'un circuit de mesure ayant des parties conductrices SOUS TENSION DANGEREUSE pouvant atteindre 1 000 V en courant alternatif ou 1 500 V en courant continu

Tension des parties conductrices de la BORNE	DISTANCE D'ISOLEMENT et LIGNE DE FUITE
V en courant alternatif efficace et V en courant continu	mm
> 30 ≤ 300	0,8
> 300 ≤ 600	1,0
> 600 ≤ 1 000	2,6
> 1 000 ≤ 1 500 ^a	2,8
NOTE Les valeurs présentées dans ce tableau ne s'appliquent pas aux tensions inférieures aux tensions ACTIVES DANGEREUSES (voir 6.3.1 a)).	
^a Pour la tension en courant continu uniquement.	

En ce qui concerne les EMBLEMES HUMIDES, aucune exigence relative à la DISTANCE D'ISOLEMENT et à la LIGNE DE FUITE n'est prévue pour les tensions comprises entre 16 V (valeur efficace) en courant alternatif et 30 V (valeur efficace) en courant alternatif, ou entre 35 V en courant continu et 60 V en courant continu. Néanmoins, les parties conductrices de la BORNE non branchée d'un circuit de mesure ne doivent pas être ACCESSIBLES.

L'Annexe CC fournit des informations concernant les dimensions recommandées des BORNES de 4 mm.

La conformité est vérifiée par examen, par la détermination des parties ACCESSIBLES, par le mesurage des DISTANCES D'ISOLEMENT et LIGNES DE FUITE applicables et, le cas échéant, par l'essai de tension de 6.8.

6.6.102 BORNES spécialisées des circuits de mesure

Les composants, les capteurs et les dispositifs prévus pour être connectés à des BORNES spécialisées des circuits de mesure ne doivent pas être à la fois ACCESSIBLES et SOUS TENSION DANGEREUSE, que ce soit en CONDITION NORMALE ou en CONDITION DE PREMIER DEFAT, même lorsque la tension ASSIGNEE la plus élevée est appliquée à n'importe quelle autre BORNE du circuit de mesure.

NOTE Ces BORNES spécialisées incluent, entre autres, les BORNES de mesure de semiconducteurs, de condensateurs et les connecteurs de thermocouple.

La conformité est vérifiée par examen et mesurage. Les composants, les capteurs et les dispositifs prévus pour être connectés à des BORNES spécialisées des circuits de mesure sont connectés. Les mesurages de 6.3 sont effectués afin de s'assurer que les niveaux de 6.3.1 et de 6.3.2 ne sont pas dépassés lorsque chacune des tensions suivantes est appliquée à n'importe quelle BORNE du circuit de mesure, selon le cas:

- a) la tension alternative ASSIGNEE la plus élevée à n'importe quelle fréquence ASSIGNEE du RESEAU;*
- b) la tension continue ASSIGNEE la plus élevée;*
- c) la tension alternative ASSIGNEE la plus élevée à la fréquence de mesure maximale ASSIGNEE associée.*

6.7.1.3 LIGNES DE FUITE

Addition:

Ajouter le nouvel alinéa suivant après le troisième alinéa:

Pour les APPAREILS PORTATIFS non alimentés par le RESEAU ou le circuit de mesure, il est admis que les LIGNES DE FUITE soient conformes au groupe de matériau I pour l'ensemble des matériaux isolants.

6.7.1.5 Exigences pour l'isolation suivant le type de circuit

Remplacement:

Remplacer le texte par le suivant:

Les exigences pour l'isolation de types particuliers de circuits sont spécifiées comme suit:

- a) en 6.7.2 pour les CIRCUITS RESEAU en CATEGORIE DE SURTENSION II avec une tension nominale d'alimentation jusqu'à 300 V;
NOTE 1 Voir l'Annexe I pour les tensions nominales des RESEAUX de distribution.
- b) en 6.7.3 pour les circuits secondaires séparés des circuits du a) au moyen seulement d'un transformateur;
- c) à l'Article K.1 pour les CIRCUITS RESEAU en CATEGORIE DE SURTENSION III ou IV, ou en CATEGORIE DE SURTENSION II au-delà de 300 V;
- d) à l'Article K.2 pour les circuits secondaires séparés des circuits du c) au moyen seulement d'un transformateur;
- e) à l'Article K.3 pour les circuits ayant une ou plusieurs des caractéristiques suivantes:
 - 1) la SURTENSION TRANSITOIRE maximale possible est limitée par la source d'alimentation ou à l'intérieur de l'appareil à une valeur connue inférieure aux valeurs supposées pour les CIRCUITS RESEAU;

- 2) la SURTENSION TRANSITOIRE maximale possible est supérieure aux valeurs supposées pour les CIRCUITS RESEAU;
 - 3) la TENSION DE SERVICE est la somme des tensions de plusieurs circuits, ou est une tension mixte;
 - 4) la TENSION DE SERVICE comporte une tension de crête répétitive avec une forme d'onde périodique non sinusoïdale ou avec une forme d'onde non périodique survenant régulièrement;
 - 5) la fréquence de la TENSION DE SERVICE est supérieure à 30 kHz;
 - 6) le circuit est un circuit de mesure pour lequel les CATEGORIES DE MESURE ne s'appliquent pas;
- f) à l'Article K.101 pour les circuits de mesure des CATEGORIES DE MESURE II, III et IV.

NOTE 2 Ces exigences sont représentées dans l'organigramme de l'Annexe DD.

NOTE 3 Voir l'Article K.3 pour les exigences des circuits à découpage tels que les alimentations de puissance à découpage.

NOTE 4 Le niveau transitoire supposé pour le RESEAU est défini au Tableau 443.2 de l'IEC 60364-4-44:2007/AMD1:2015.

7 Protection contre les DANGERS mécaniques

L'article de la Partie 1 est applicable.

8 Résistance aux contraintes mécaniques

L'article de la Partie 1 est applicable.

9 Protection contre la propagation du feu

L'article de la Partie 1 est applicable.

10 Limites de température de l'appareil et résistance à la chaleur

L'article de la Partie 1 est applicable.

11 Protection contre les DANGERS des fluides et des corps solides étrangers

L'article de la Partie 1 est applicable.

12 Protection contre les radiations, y compris les sources laser, et contre la pression acoustique et ultrasonique

L'article de la Partie 1 est applicable.

13 Protection contre les émissions de gaz et substances, les explosions et les implosions

L'article de la Partie 1 est applicable.

14 Composants et sous-ensembles

L'article de la Partie 1 est applicable à l'exception de ce qui suit:

Addition:

Ajouter les nouveaux paragraphes suivants:

14.101 Circuits utilisés comme limiteurs de SURTENSIONS TRANSITOIRES dans les circuits de mesure utilisés sur un RESEAU

Si les SURTENSIONS TRANSITOIRES sont limitées dans un circuit de mesure utilisé sur un RESEAU, le composant ou le circuit de limitation des surtensions doit avoir la tenue adaptée pour limiter les SURTENSIONS TRANSITOIRES potentielles.

La conformité est vérifiée en appliquant cinq impulsions positives et cinq impulsions négatives espacées entre elles de 1 min au maximum avec la tension de choc applicable du Tableau 102 fournie par un générateur de choc hybride (voir l'IEC 61180-1). Le générateur produit une tension de forme d'onde 1,2/50 μ s en circuit ouvert, un courant de court-circuit de forme d'onde 8/20 μ s, avec une impédance de sortie (valeur de crête de la tension en circuit ouvert divisée par la valeur de crête du courant de court-circuit) de 2 Ω en CATEGORIES DE MESURE III et IV ou de 12 Ω en CATEGORIE DE MESURE II. Une résistance peut être ajoutée en série si nécessaire pour augmenter l'impédance.

La tension d'essai est appliquée tandis que le circuit fonctionne en conditions d'UTILISATION NORMALE en combinaison avec la tension RESEAU entre chaque paire de BORNES utilisée sur le RESEAU comportant des composants ou des circuits limiteurs de tension.

La tension RESEAU est la tension phase-neutre maximale ASSIGNEE du RESEAU en cours de mesure. Pour les circuits de mesure dont les tensions ASSIGNEES équivalent à des tensions phase-neutre du RESEAU supérieures à 400 V (valeur efficace) en courant alternatif ou en courant continu, l'essai peut être réalisé avec une source de tension disponible ayant une tension phase-neutre au moins égale à 400 V (valeur efficace) en courant alternatif ou en courant continu. Dans ce cas, il n'est pas nécessaire que la source de tension corresponde aux CARACTERISTIQUES ASSIGNEES du circuit de mesure. Néanmoins, les circuits pour lesquels le courant alternatif est une CARACTERISTIQUE ASSIGNEE sont soumis à l'essai avec une source de courant alternatif et les circuits pour lesquels le courant continu est une CARACTERISTIQUE ASSIGNEE sont soumis à l'essai avec une source de courant continu.

NOTE Cet essai peut être extrêmement dangereux. Des enceintes antidéflagrantes et d'autres dispositions peuvent être utilisées pour protéger le personnel en charge de l'essai.

Le composant ou circuit limiteur de surtensions ne doit pas se rompre ou surchauffer pendant l'essai. Si les résultats de l'essai sont contestables ou peu concluants, l'essai doit être répété deux nouvelles fois.

Tableau 102 – Tensions de choc

Tension nominale phase-neutre efficace alternative ou continue du RESEAU en cours de mesure V	Tension de choc V		
	CATEGORIE DE MESURE II	CATEGORIE DE MESURE III	CATEGORIE DE MESURE 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 Pour la tension en courant continu uniquement.			

14.102 Sondes équipées et accessoires

Les sondes équipées et accessoires relevant du domaine d'application de l'IEC 61010-031 et les capteurs de courant relevant du domaine d'application de l'IEC 61010-2-032 doivent satisfaire aux exigences applicables.

La conformité est vérifiée par examen.

15 Protection par systèmes de verrouillage

L'article de la Partie 1 est applicable.

16 DANGERS résultant de l'application

L'article de la Partie 1 est applicable.

17 Appréciation du RISQUE

L'article de la Partie 1 est applicable.

Addition:

Ajouter le nouvel article suivant:

101 Circuits de mesure**101.1 Généralités**

L'appareil doit assurer une protection contre les DANGERS résultant de l'UTILISATION NORMALE et du MAUVAIS USAGE RAISONNABLEMENT PREVISIBLE des circuits de mesure, comme indiqué ci-dessous.

- a) Un circuit de mesure de courant ne doit pas interrompre le circuit en cours de mesure en cas de changement de calibre ou lors de l'utilisation de transformateurs de courant sans protection interne si cela peut provoquer un DANGER (voir 101.2).