

INTERNATIONAL STANDARD



GROUP SAFETY PUBLICATION

Safety requirements for electrical equipment for measurement, control, and laboratory use –

Part 031: Safety requirements for hand-held and hand-manipulated probe assemblies for electrical test and measurement



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2022 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.



IEC 61010-031

Edition 3.0 2022-12
COMMENTED VERSION

INTERNATIONAL STANDARD



GROUP SAFETY PUBLICATION

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 19.080

ISBN 978-2-8322-6316-7

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	7
1 Scope ~~and object~~	10
2 Normative references	10
3 Terms and definitions	11
3.1 Parts and accessories	11
3.2 Quantities	12
3.3 Tests	13
3.4 Safety terms	13
3.5 Insulation	14
4 General	15
4.1 Type of probe assemblies	15
4.2 ~~Object~~ Safety aspects	22
4.2.1 ~~Aspects included in scope~~ Identified HAZARDS	22
4.2.2 Aspects excluded ~~from scope~~	22
4.3 Verification	23
4.4 Environmental conditions	23
4.4.1 Normal environmental conditions	23
4.4.2 Extended environmental conditions	23
5 Tests	23
5.1 General	23
5.2 Sequence of tests	24
5.3 Reference test conditions	24
5.3.1 Environmental conditions	24
5.3.2 State of probe assemblies	24
5.3.3 Position of the probe assembly	24
5.3.4 Accessories	25
5.3.5 Covers and removable parts	25
5.3.6 Input and output voltages	25
5.3.7 Controls	25
5.3.8 Connections	25
5.3.9 Short-term or intermittent operation	25
5.4 Testing in SINGLE FAULT CONDITION	25
5.4.1 General	25
5.4.2 Application of fault conditions	25
5.4.3 Duration of tests	26
5.4.4 Conformity after application of fault conditions	26
5.5 Tests in REASONABLY FORESEEABLE MISUSE	27
5.5.1 General	27
5.5.2 Fuses	27
6 Marking and documentation	27
6.1 Marking	27
6.1.1 General	27
6.1.2 Identification	28
6.1.3 Fuses	29
6.1.4 CONNECTORS and operating devices	29
6.1.5 RATING	29



6.2	Warning markings.....	29
6.3	Durability of markings	30
6.4	Documentation	30
6.4.1	General.....	30
6.4.2	Probe assembly RATING	30
6.4.3	Probe assembly operation	30
6.4.4	Probe assembly maintenance and service	31
7	Protection against electric shock	32
7.1	General.....	32
7.2	Determination of ACCESSIBLE parts.....	32
7.2.1	General.....	32
7.2.2	Examination	32
7.2.3	Openings for pre-set controls.....	34
7.3	Limit values for ACCESSIBLE parts	34
7.3.1	General.....	34
7.3.2	Levels in NORMAL CONDITION	35
7.3.3	Levels in SINGLE FAULT CONDITION	35
7.3.4	Measurement of voltage and touch current.....	37
7.4	Means of protection against electric shock	40
7.4.1	General.....	40
7.4.2	CONNECTORS	41
7.4.3	PROBE TIPS	43
7.4.4	Impedance	47
7.4.5	PROTECTIVE IMPEDANCE	47
7.4.6	BASIC INSULATION, SUPPLEMENTARY INSULATION, DOUBLE INSULATION and REINFORCED INSULATION	47
7.5	Insulation requirements.....	48
7.5.1	The nature of insulation	48
7.5.3	CREEPAGE DISTANCES	54
7.5.4	Solid insulation for probe assemblies	56
7.6	Procedure for voltage tests	63
7.6.1	General.....	63
7.6.2	Humidity preconditioning.....	63
7.6.3	Conduct of tests	64
7.6.4	Test voltages.....	64
7.6.5	Test procedures	66
7.7	Constructional requirements for protection against electric shock.....	67
7.7.1	General.....	67
7.7.2	Insulating materials	67
7.7.3	ENCLOSURES of probe assemblies with DOUBLE INSULATION or REINFORCED INSULATION	67
7.7.4	PROBE WIRE attachment	68
8	Protection against mechanical HAZARDS	71
9	Resistance to mechanical stresses	71
9.1	General.....	71
9.2	Rigidity test	72
9.3	Drop test.....	72
9.4	Impact swing test.....	72
10	Temperature limits ~~and protection against the spread of fire~~	72

~~9.1~~	~~General~~	~~74~~
~~9.2~~	~~Temperature tests~~	~~74~~
~~10~~	~~Resistance to heat~~	~~74~~
~~10.1~~	~~Integrity of SPACINGS~~	~~74~~
~~10.2~~	~~Resistance to heat~~	~~74~~
11	Protection against HAZARDS from fluids	74
11.1	Cleaning	75
11.2	Specially protected probe assemblies	75
12	Components	75
12.1	General	75
12.2	Fuses	76
12.3	PROBE WIRE	76
12.3.1	General	76
12.3.2	RATING of PROBE WIRE	76
12.3.3	Pressure test at high temperature for insulations	77
12.3.4	Tests for resistance of insulation to cracking	78
12.3.5	Voltage test	79
12.3.6	Tensile test	79
13	Prevention of HAZARD from arc flash and short-circuits	81
13.1	General	81
13.2	Exposed conductive parts	81
Annex A (normative)	Measuring circuits for touch current (see 7.3)	83
A.1	Measuring circuits for AC with frequencies up to 1 MHz and for DC	83
A.2	Measuring circuits for AC with sinusoidal frequencies up to 100 Hz and for DC	83
A.3	Current measuring circuit for electrical burns at frequencies above 100 kHz	84
A.4	Current measuring circuit for WET LOCATIONS	85
Annex B (normative)	Standard test fingers	87
Annex C (normative)	Measurement of CLEARANCES and CREEPAGE DISTANCES	90
Annex D (normative)	Routine spark tests on PROBE WIRE	92
D.1	General	92
D.2	Spark test procedure	92
D.3	Routine spark test method for PROBE WIRE	94
Annex E (informative)	4 mm CONNECTORS	96
E.1	General	96
E.2	Dimensions	96
Annex F (normative)	MEASUREMENT CATEGORIES	98
F.1	General	98
F.2	MEASUREMENT CATEGORIES	98
F.2.1	MEASUREMENT CATEGORY II	98
F.2.2	MEASUREMENT CATEGORY III	98
F.2.3	MEASUREMENT CATEGORY IV	98
F.2.4	Probe assemblies without a MEASUREMENT CATEGORY RATING	99
Annex G (informative)	Determination of CLEARANCES for Table 2	102
Annex H (informative)	Line-to-neutral voltages for common mains supply systems	103
Annex I (informative)	Index of defined terms	105
Bibliography		107

List of comments.....	109
Figure 1 – Example of a STACKABLE CONNECTOR with a male CONNECTOR and a female TERMINAL.....	12
Figure 2 – Examples of Type A probe assemblies	16
~~Figure 3 – Examples of type C probe assemblies~~	~~16~~
Figure 3 – Example of Type B probe assemblies	18
Figure 4 – Examples of Type D probe assemblies	21
Figure 5 – Examples of Type E probe assemblies	21
Figure 6 – Examples of Type F probe assemblies.....	22
Figure 7 – Methods for determination of ACCESSIBLE parts ~~(see 6.2)~~ ~~and for voltage tests of (see 6.4.2)~~	34
Figure 8 – Capacitance level versus voltage in NORMAL CONDITION and SINGLE FAULT CONDITION (see 7.3.2 c) and 7.3.3 c))	36
Figure 9 – Voltage and touch current measurement.....	37
Figure 10 – Voltage and touch current measurement for the REFERENCE CONNECTOR	38
Figure 11 – Voltage and touch current measurement with shielded test probe	39
Figure 12 – Maximum test probe input voltage for 70 mA touch current.....	40
Figure 13 – Protection by a PROTECTIVE FINGERGUARD.....	44
Figure 14 – Protection by distance.....	45
Figure 15 – Protection by tactile indicator	46
Figure 16 – Example of probe assembly with IP2X PROBE TIP.....	46
Figure 17 – Example of recurring peak voltage.....	53
Figure 18 – Distance between conductors on an interface between two layers	58
Figure 19 – Distance between adjacent conductors along an interface of two layers.....	59
Figure 20 – Distance between adjacent conductors located between the same two layers	61
Figure 21 – Flexing test.....	69
Figure 22 – Rotational flexing test	71
Figure 23 – Impact swing test.....	73
Figure 24 – Indentation device.....	77
Figure A.1 – Measuring circuit for AC with frequencies up to 1 MHz and for DC	83
Figure A.2 – Measuring circuits for AC with sinusoidal frequencies up to 100 Hz and for DC.....	84
Figure A.3 – Current measuring circuit for electrical burns.....	85
Figure A.4 – Current measuring circuit for high frequency test probes.....	85
Figure A.5 – Current measuring circuit for WET LOCATIONS.....	86
Figure B.1 – Rigid test finger	87
Figure B.2 – Jointed test finger.....	88
Figure D.1 – Bead chain configuration (if applicable).....	93
Figure E.1 – Recommended dimensions of 4 mm CONNECTORS	97
Figure F.1 – Example to identify the locations of MEASUREMENT CATEGORIES	100
Table 1 – Symbols	28

~~Table 2 – SPACINGS for unmated CONNECTORS RATED up to 1 000 V a.c. or 1 500 V d.c. with HAZARDOUS LIVE conductive parts~~

Table 2 – CLEARANCES for unmated CONNECTORS	43
Table 3 – Multiplication factors for CLEARANCES of probe assembly RATED for operation at altitudes up to 5 000 m	49
Table 4 – CLEARANCES for probe assemblies RATED for MEASUREMENT CATEGORIES	49
Table 5 – CLEARANCE values for the calculation of 7.5.2.3.2	52
Table 6 – CLEARANCES for BASIC INSULATION in probe assemblies subjected to recurring peak voltages or WORKING VOLTAGES with frequencies above 30 kHz	54
Table 7 – CREEPAGE DISTANCES for BASIC INSULATION or SUPPLEMENTARY INSULATION	54
Table 8 – Impulse test voltages for testing electric strength of solid insulation for probe assemblies RATED for MEASUREMENT CATEGORIES	57
Table 9 – AC test voltages for testing electric strength of solid insulation for probe assemblies RATED for MEASUREMENT CATEGORIES	57
Table 10 – Minimum values for distance or thickness of solid insulation for probe assemblies RATED for MEASUREMENT CATEGORIES	59
Table 11 – Test voltages based on CLEARANCES	65
Table 12 – Correction factors according to test site altitude for test voltages for CLEARANCES	66
Table 13 – Pull forces for PROBE WIRE attachment tests	70
Table 14 – Surface temperature limits in NORMAL CONDITION	73
Table 15 – Diameter of mandrel and numbers of turns	78
Table C.1 – Dimension of X	90
Table C.2 – Methods of measuring CLEARANCES and CREEPAGE DISTANCES	90
Table D.1 – Maximum centre-to-centre spacings of bead chains	92
Table D.2 – Formula for maximum speed of wire in terms of electrode length L of link- or bead-chain electrode	94
Table F.1 – Characteristics of MEASUREMENT CATEGORIES	101
Table G.1 – CLEARANCES values for Table 2	102
Table H.1 – Line-to-neutral voltages for common mains supply systems	104

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT
FOR MEASUREMENT, CONTROL, AND LABORATORY USE –****Part 031: Safety requirements for hand-held and hand-manipulated
probe assemblies for electrical test and measurement**

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This commented version (CMV) of the official standard IEC 61010-031:2022 edition 3.0 allows the user to identify the changes made to the previous IEC 61010-031:2015+AMD1:2018 CSV edition 2.1. Furthermore, comments from IEC TC 66 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

IEC 61010-031 has been prepared by IEC technical committee 66: Safety of measuring, control and laboratory equipment. It is an International Standard.

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

This third edition cancels and replaces the second edition published in 2015, and Amendment 1:2018. IEC 61010-031 is a stand-alone standard.

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

- a) the scope has been made succinct. General information from the scope of Edition 2 has been moved to a new Clause 4. Consequently, Clause 4 to Clause 8 of Edition 2 have been renumbered. Clause 9 of Edition 2 has been deleted;
- b) in Clause 2, normative references have been dated and new normative references have been added;
- c) in 3.1.4, the definition of PROBE TIP has been modified;
- d) in 4.1, there is no longer any differentiation between high voltage and low voltage probe assemblies. Type C probe assemblies have been merged with Type B probe assemblies;
- e) in 4.1 d) "Kelvin" probes have been added to the list of probe assemblies as a new Type E and a new Figure 5;
- f) in 4.1 e), probes for voltage measurement without electrical connection to conductors have been added to the list of probe assemblies as a new Type F and a new Figure 6;
- g) in 4.2.1, spread of fire is no longer considered as a HAZARD;
- h) Subclause 4.4.2.5 from Edition 2 has been deleted;
- i) Subclause 4.4.4.3 from Edition 2 has been deleted;
- j) in 5.4.4.1 consideration has been given to SPACINGS and impedance;
- k) in 6.1.1, removable parts of PROBE TIPS which bear markings are allowed;
- l) in 6.1.5, the voltage to be marked for MEASUREMENT CATEGORIES is the AC line-to-neutral or DC voltage;
- m) in 7.4.2, requirements for unmated CONNECTORS have been modified as follows:
 - 1) Table 2 has been modified and expanded,
 - 2) a calculation method for CLEARANCES of CONNECTORS above 20 kV has been defined,
 - 3) CREEPAGE DISTANCES have been aligned with CLEARANCES;
- n) in 7.4.3.1 and 7.4.3.5, requirements for IP2X PROBE TIPS with retractable sleeve have been added;
- o) in 7.4.3.2, PROBE TIPS are now applicable to non-contact probe assemblies;
- p) in 7.5.2.3.2, the values of Table 5 have been modified;
- q) in 7.6.2, voltage tests of CLEARANCES are done without humidity preconditioning;
- r) pre-treatments for rigidity test from Clause 10 of Edition 2 have been moved to 9.2;
- s) Subclause 11.1 of Edition 2 has been deleted;
- t) addition of an exception for Type E probe assembly in 13.2. Removable parts of PROBE TIPS which bear markings are allowed;
- u) Figure F.1 has been modified;
- v) Annex G has been added, for determination of CLEARANCES for Table 2;
- w) Annex H has been added, covering line-to-neutral voltages for common mains supply systems.

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

Draft	Report on voting
66/770/FDIS	66/771/RVD

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

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

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

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

In this document the following print types are used:

- requirements and definitions: in roman type;
- NOTES and EXAMPLES: in smaller roman type;
- *conformity and tests: in italic type;*
- terms used throughout this document which have been defined in Clause 3: SMALL ROMAN CAPITALS.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

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

Part 031: Safety requirements for hand-held and hand-manipulated probe assemblies for electrical test and measurement

1 ~~Scope and object~~ 1

~~1.1 Scope~~

~~1.1.1 Probe assemblies included in scope~~

This part of IEC 61010 specifies safety requirements for hand-held and hand-manipulated probe assemblies ~~of the types described below~~ for electrical test and measurement, and their related accessories. These probe assemblies are for non-contact 2 or direct electrical connection between a part and electrical test and measurement equipment. They ~~may~~ can be fixed to the equipment or be detachable accessories for the equipment.

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

One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications and/or group safety publications in the preparation of its publications. 3

2 Normative references 4

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

~~IEC 60027 (all parts), Letter symbols to be used in electrical technology~~

IEC 60027-1:1992, *Letter symbols to be used in electrical technology – Part 1: General*
IEC 60027-1:1992/AMD1:1997
IEC 60027-1:1992/AMD2:2005

IEC 60027-2:2019, *Letter symbols to be used in electrical technology – Part 2: Telecommunications and electronics*

IEC 60027-4:2006, *Letter symbols to be used in electrical technology – Part 4: Rotating electric machines*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*
IEC 60529:1989/AMD1:1999
IEC 60529:1989/AMD2:2013

IEC 61010-1:2010, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*
IEC 61010-1:2010/AMD1:2016

IEC 61180:2016, *High-voltage test techniques for low-voltage equipment – Definitions, test and procedure requirements, test equipment*

~~IEC 61180-1:1992, High-voltage test techniques for low-voltage equipment – Part 1: Definitions, test and procedure requirements~~

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

~~IEC GUIDE 104, The preparation of safety publications and the use of basic safety publications and group safety publications~~

~~ISO/IEC GUIDE 51, Safety aspects – Guidelines for their inclusion in standards~~

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply (see Annex I for index of defined terms).

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1 Parts and accessories

3.1.1

TERMINAL

component provided for the connection of a device (equipment) to external conductors

Note 1 to entry: TERMINALS can contain one or several contacts and the term includes sockets, pins, etc.

3.1.2

ENCLOSURE

part providing protection of a probe assembly against certain external influences and, in any direction, protection against direct contact

3.1.3

PROTECTIVE FINGERGUARD

part of the ENCLOSURE that indicates the limit of safe access and that reduces the risk of the OPERATOR touching HAZARDOUS LIVE parts

3.1.4

PROBE TIP

part of a probe assembly or accessory which ~~makes a connection to~~ can touch **5** the point being measured or tested

~~Note 1 to entry: The term "PROBE TIP" includes the conductive parts of the jaws or hooks of SPRING-LOADED CLIPS.~~

3.1.5

CONNECTOR

component which is attached to the PROBE WIRE, to connect the probe assembly to a TERMINAL of the equipment or to another probe assembly

3.1.6

REFERENCE CONNECTOR **6**

CONNECTOR for connection to a reference point

3.1.7

TOOL

external device, including a key or coin, used to aid a person performing a mechanical function

3.1.8

PROBE WIRE

flexible wire or cable used as part of the probe assembly or its accessories, consisting of one or more conductors and associated insulation

3.1.9

SPRING-LOADED CLIP

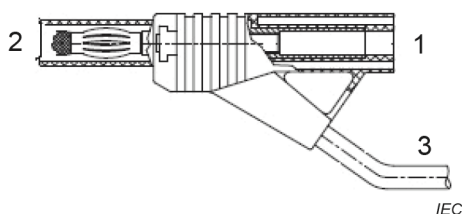
probe or probe accessory with one or more hooks or jaws forced by a spring to grip the part being measured or tested

3.1.10

STACKABLE CONNECTOR

CONNECTOR assembly which contains an additional TERMINAL

EXAMPLE Figure 1 is an example of a STACKABLE CONNECTOR with a male CONNECTOR and a female TERMINAL.



Key

- 1 TERMINAL for ADDITIONAL CONNECTOR
- 2 CONNECTOR
- 3 PROBE WIRE

Figure 1 – Example of a STACKABLE CONNECTOR with a male CONNECTOR and a female TERMINAL

3.2 Quantities

3.2.1

RATED ~~(condition or value)~~

RATED value

condition or quantity value assigned, generally by a manufacturer, for a specified operating condition of a component, device, or probe assembly

3.2.2

RATING

set of RATED values and operating conditions

[SOURCE: IEC 60050-151:2001, 151-16-11]

3.2.3

WORKING VOLTAGE

highest RMS value of the AC or DC voltage across any particular insulation which can continuously appear during NORMAL USE

Note 1 to entry: Transients and voltage fluctuations are not considered to be part of the WORKING VOLTAGE.

3.3 Tests

3.3.1

TYPE TEST

test of one or more samples of a probe assembly (or parts of a probe assembly) made to a particular design, to show that the design and construction meet the requirements of this document

Note 1 to entry: This is an ~~amplification~~ enlargement of the IEC 60050-151:2001, 151-16-16 definition to cover design as well as construction.

3.3.2

ROUTINE TEST

conformity test made on each individual item during or after manufacture

[SOURCE: IEC 60050-151:2001, 151-16-17]

3.4 Safety terms

3.4.1

ACCESSIBLE

able to be touched with a standard test finger or test pin, when used as specified in 7.2

3.4.2

HAZARDOUS LIVE

capable of rendering an electric shock or electric burn

3.4.3

HAZARD

potential source of harm

3.4.4

PROTECTIVE IMPEDANCE

component or assembly of components whose impedance, construction and reliability are suitable to provide protection against electric shock

3.4.5

NORMAL USE

operation, including stand-by, according to the instructions for use or for the obvious intended purpose

3.4.6

NORMAL CONDITION

condition in which all means for protection against HAZARDS are intact

3.4.7

SINGLE FAULT CONDITION **7**

condition in which one means for protection against a HAZARD is defective or one fault is present which could cause a HAZARD

Note 1 to entry: If a SINGLE FAULT CONDITION results unavoidably in one or more other fault conditions, all the failures are considered as one SINGLE FAULT CONDITION.

3.4.8

OPERATOR

person operating the probe assembly for its intended purpose

3.4.9

RESPONSIBLE BODY

individual or group responsible for the safe use and maintenance of probe assemblies

3.4.10

WET LOCATION

location where water or another conductive liquid may be present and is likely to cause reduced human body impedance due to wetting of the contact between the human body and the probe assembly, or wetting of the contact between the human body and the environment

3.4.11

MEASUREMENT CATEGORY **8**

classification of testing and measuring circuits according to the types 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 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 F for more information).

3.4.12

REASONABLY FORESEEABLE MISUSE

use of a product in a way not intended by the supplier, but which may result from readily predictable human behaviour

3.5 Insulation

3.5.1

BASIC INSULATION **9**

insulation ~~of HAZARDOUS LIVE parts~~ which provides basic protection

Note 1 to entry: This concept does not apply to insulation used exclusively for functional purposes.

[SOURCE: IEC 60050-195:1998/2021, 195-06-06]

3.5.2

SUPPLEMENTARY INSULATION **10**

independent insulation applied in addition to BASIC INSULATION ~~in order to provide protection against electric shock in the event of a failure of BASIC INSULATION~~ that provides fault protection

[SOURCE: IEC 60050-195:2021, 195-06-07]

3.5.3

DOUBLE INSULATION

insulation comprising both BASIC INSULATION and SUPPLEMENTARY INSULATION

[SOURCE: IEC 60050-195:1998/2021, 195-06-08]

3.5.4

REINFORCED INSULATION **11**

insulation that provides a degree of protection against electric shock ~~not less than that provided by~~ equivalent to DOUBLE INSULATION

Note 1 to entry: REINFORCED INSULATION can comprise several layers that cannot be tested singly as BASIC INSULATION or SUPPLEMENTARY INSULATION.

[SOURCE: IEC 60050-195:2021, 195-06-09]

3.5.5

POLLUTION

addition of foreign matter, solid, liquid or gaseous (ionized gases), that ~~may~~ can produce a reduction of dielectric strength or surface resistivity

3.5.6**POLLUTION DEGREE**

numeral indicating the level of POLLUTION that ~~may~~ can be present in the environment

3.5.7**POLLUTION DEGREE 1**

no POLLUTION or only dry, non-conductive POLLUTION occurs, which has no influence

3.5.8**POLLUTION DEGREE 2**

only non-conductive POLLUTION occurs except that occasionally a temporary conductivity caused by condensation is expected

3.5.9**POLLUTION DEGREE 3 12**

conductive POLLUTION occurs, or dry, non-conductive POLLUTION occurs which becomes conductive due to condensation which is expected

Note 1 to entry: In such conditions, probe assembly is normally protected against exposure to direct sunlight, precipitation, and full wind pressure, but neither temperature nor humidity is controlled.

3.5.10**CLEARANCE**

shortest distance in air between two conductive parts

3.5.11**CREEPAGE DISTANCE**

shortest distance along the surface of a solid insulating material between two conductive parts

[SOURCE: IEC 60050-151:2001, 151-15-50]

3.5.12**SPACING**

any combination of CLEARANCES and CREEPAGE DISTANCES

4 General**4.1 Type of probe assemblies**

The safety of the following types of probe assemblies are covered by this document.

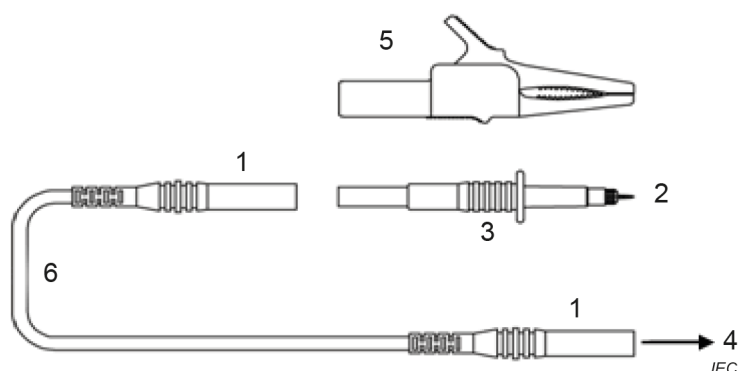
- a) Type A: ~~low-voltage and high-voltage~~, non-attenuating probe assemblies. Non-attenuating probe assemblies that are RATED for direct connection to voltages exceeding 30 V AC RMS, 42,4 V peak, or 60 V DC, but not exceeding 63 kV. They do not incorporate components which are intended to provide a voltage divider function or a signal conditioning function, but they ~~may~~ can contain non-attenuating components such as fuses (see Figure 2).
- b) Type B: ~~high-voltage~~ attenuating or divider probe assemblies. Attenuating or divider probe assemblies that are RATED for direct connection to ~~secondary~~ voltages exceeding ~~1 kV r.m.s. or 1,5 kV d.c.~~ 30 V AC RMS, 42,4 V peak, or 60 V DC but not exceeding 63 kV ~~r.m.s. or d.c.~~. The divider function ~~may~~ can be carried out wholly within the probe assembly, or partly within the test or measurement equipment to be used with the probe assembly (see Figure 3 a) and Figure 3 b)).
- ~~b) Type C: low-voltage attenuating or divider probe assemblies. Attenuating or divider probe assemblies for direct connection to voltages not exceeding 1 kV r.m.s. or 1,5 kV d.c. The signal conditioning function may be carried out wholly within the probe assembly, or partly within the test or measurement equipment intended to be used with the probe assembly (see Figure 3).~~ **13**

- c) Type D: ~~low voltage~~ attenuating, non-attenuating or other signal conditioning probe assemblies that are RATED for direct connection only to voltages not exceeding 30 V AC RMS, 42,4 V peak, or 60 V DC, and are suitable for currents exceeding 8 A (see Figure 4).
- d) Type E: non-attenuating probe assemblies for 4-pole precise resistance measurements (see Figure 5). **14**

EXAMPLE: Kelvin probes.

- e) Type F: probe assemblies for non-contact AC voltage test and measurement. These probe assemblies are intended for use on insulated or non-insulated conductors without electrical contact (see Figure 6). **15**

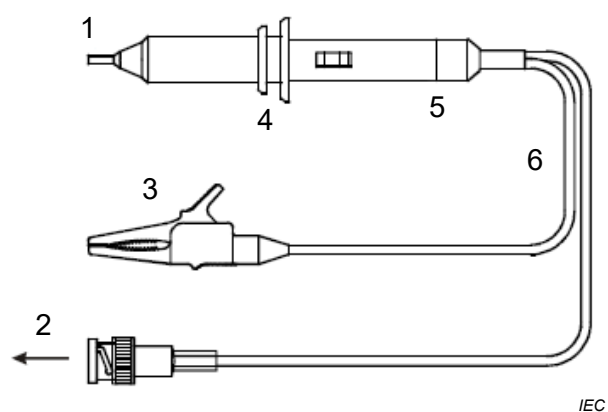
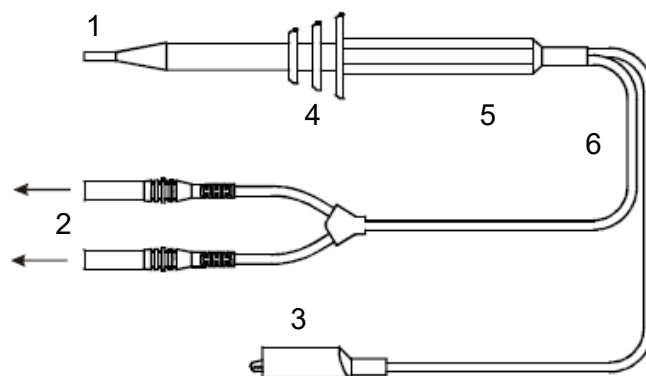
NOTE Type F probe assemblies can be stand-alone probes or connected by a PROBE WIRE to equipment.



Key

- | | | | |
|---|---|---|--------------------|
| 1 | CONNECTOR (typical- ~~CONNECTORS~~) | 4 | to equipment |
| 2 | PROBE TIP | 5 | SPRING-LOADED CLIP |
| 3 | hand-held area of probe body | 6 | PROBE WIRE |

Figure 2 – Examples of Type A probe assemblies



IEC

Key

1—PROBE TIP

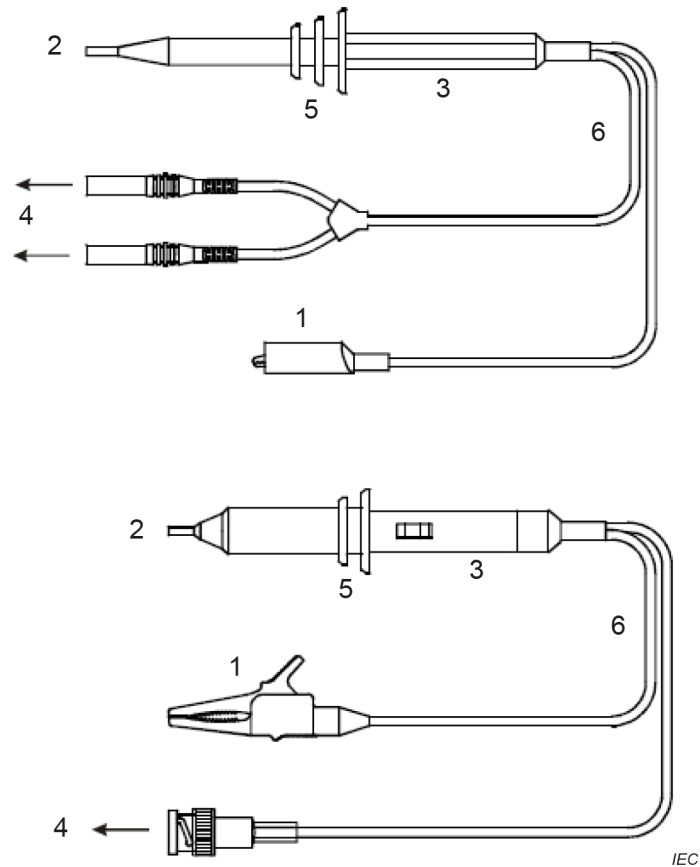
2—to equipment

3—reference CONNECTOR

4—PROTECTIVE FINGERGUARD

5—hand-held area of probe body

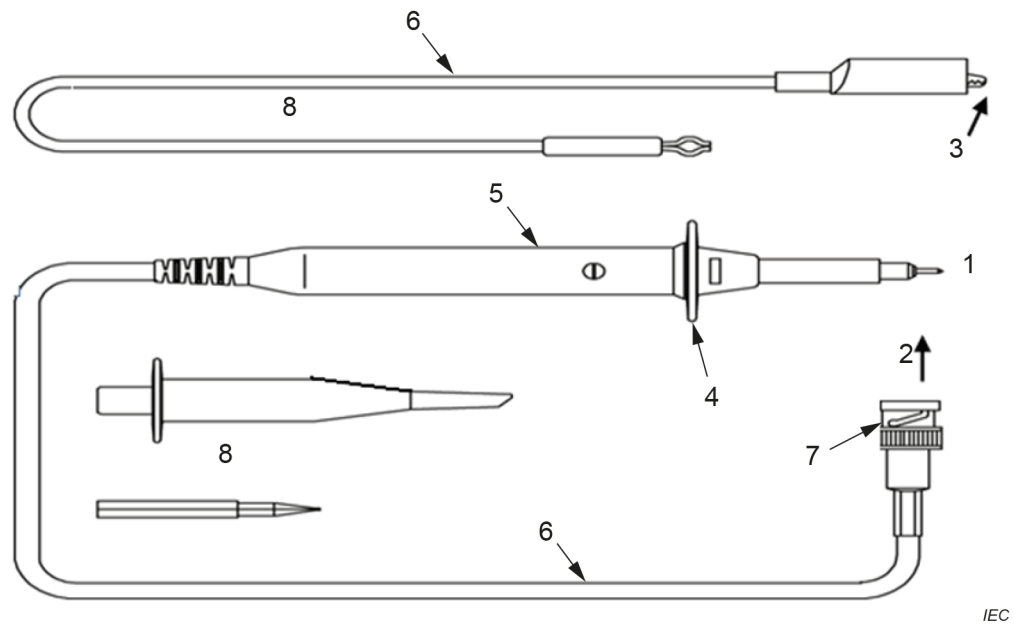
6—PROBE WIRE



Key

- | | | | |
|---|------------------------------|---|------------------------|
| 1 | REFERENCE CONNECTOR | 4 | to equipment |
| 2 | PROBE TIP | 5 | PROTECTIVE FINGERGUARD |
| 3 | hand-held area of probe body | 6 | PROBE WIRE |

Figure 3 a) – High-voltage Type B probe assemblies

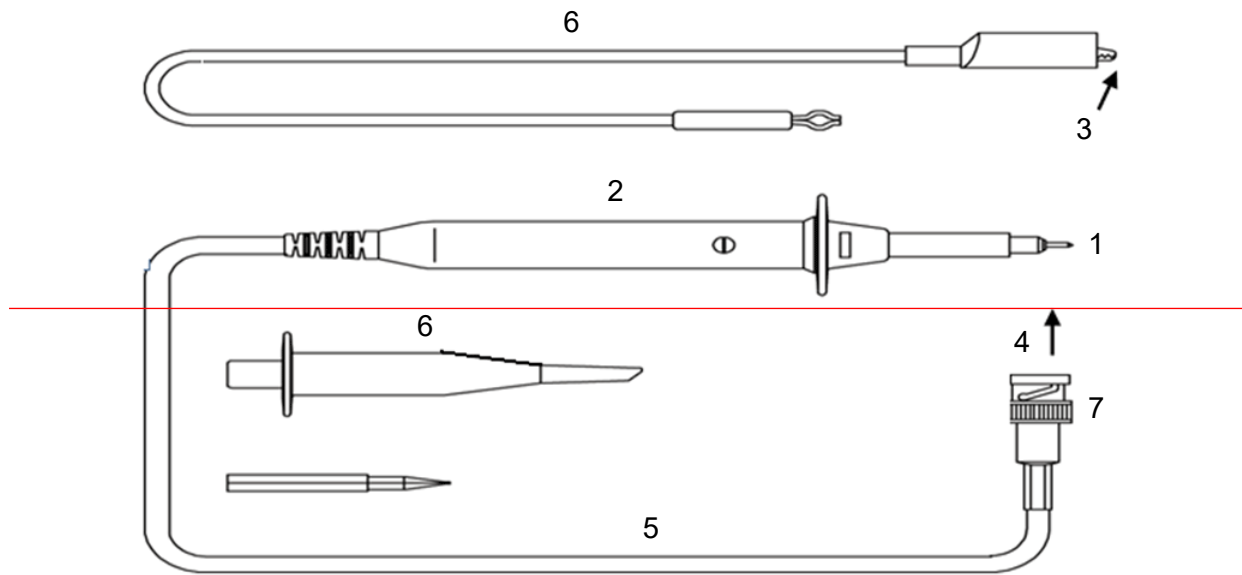


Key

- | | |
|--------------------------|--------------------------------|
| 1 PROBE TIP | 5 hand-held area of probe body |
| 2 to equipment | 6 PROBE WIRE |
| 3 REFERENCE CONNECTOR | 7 BNC CONNECTOR |
| 4 PROTECTIVE FINGERGUARD | 8 examples of accessories |

Figure 3 b) – Low-voltage Type B probe assemblies

Figure 3 – Example of Type B probe assemblies



IEC

Key

1—PROBE TIP

5—PROBE WIRE

2—probe body

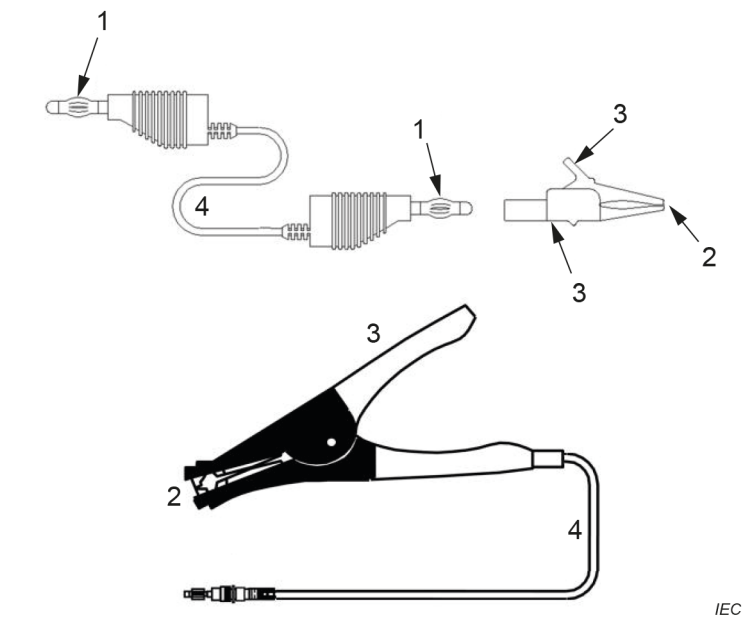
6—examples of accessories

3—reference CONNECTOR

7—BNC CONNECTOR

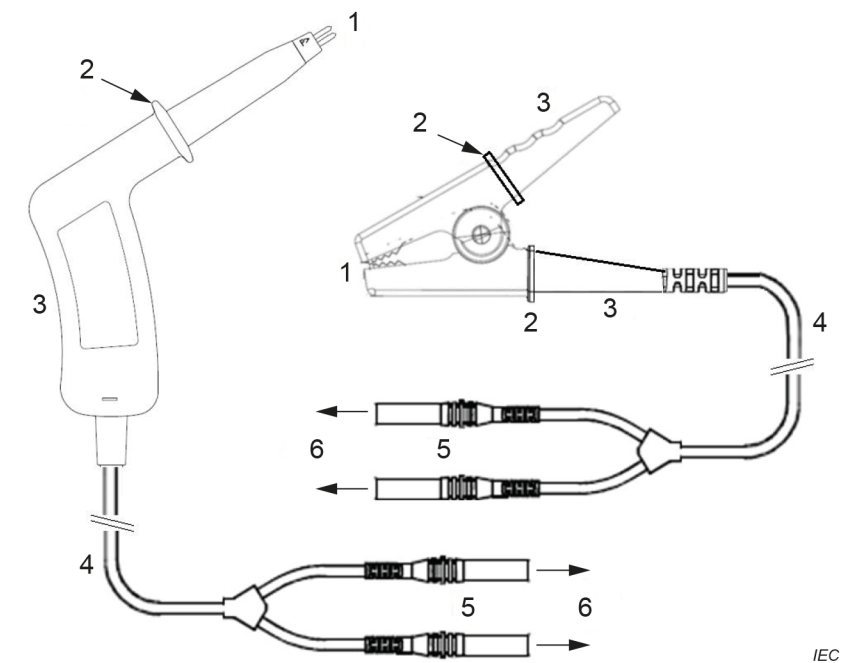
4—to equipment

Figure 3—Examples of type C probe assemblies



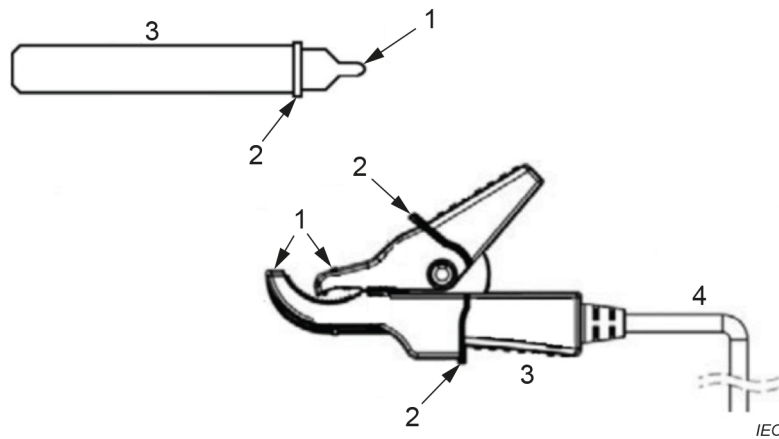
- Key**
- | | | | |
|---|-----------|---|--------------------------------------|
| 1 | CONNECTOR | 3 | hand-held area of SPRING-LOADED CLIP |
| 2 | PROBE TIP | 4 | PROBE WIRE |

Figure 4 – Examples of Type D probe assemblies



- Key**
- | | | | |
|---|------------------------------|---|--------------|
| 1 | PROBE TIP | 4 | PROBE WIRE |
| 2 | PROTECTIVE FINGERGUARD | 5 | CONNECTORS |
| 3 | hand-held area of probe body | 6 | to equipment |

Figure 5 – Examples of Type E probe assemblies



Key

- | | |
|--------------------------|--------------------------------|
| 1 PROBE TIP | 3 hand-held area of probe body |
| 2 PROTECTIVE FINGERGUARD | 4 PROBE WIRE to equipment |

Figure 6 – Examples of Type F probe assemblies

1.1.2 ~~Probe assemblies excluded from scope~~

This document does not apply to current sensors within the scope of IEC 61010-2-032:2019 (~~Hand-held and hand-manipulated current sensors~~), but may apply to their input measuring circuit leads and accessories.

4.2 Object Safety aspects

4.2.1 ~~Aspects included in scope~~ Identified HAZARDS

The purpose of the requirements of this document is to ensure that HAZARDS to the OPERATOR and the surrounding area are reduced to a tolerable level.

Requirements for protection against particular types of HAZARDS are given in Clause 7 to Clause 11 and Clause 13, as follows:

- a) electric shock or burn (see Clause 7);
- b) mechanical HAZARDS (see Clause 8 and Clause 9);
- c) excessive temperature (see Clause 10); **16**
- ~~d) spread of fire from the probe assembly (see Clause 9);~~
- d) effects of fluids (see Clause 11); **17**
- e) arc flash (see Clause 13).

Additional requirements for probe assemblies which are designed to be powered from a low-voltage mains supply, or include other features not specifically addressed in this document are in other parts of IEC 61010. **18**

NOTE Attention is drawn to the possible existence of additional requirements regarding the health and safety of labour forces.

4.2.2 Aspects excluded ~~from scope~~

This document does not cover:

- a) reliable function, performance, or other properties of the probe assembly;
- b) effectiveness of transport packaging.

4.3 Verification

This document also specifies methods of verifying that the probe assembly meets the requirements of this document, through inspection, TYPE TESTS, and ROUTINE TESTS.

4.4 Environmental conditions

4.4.1 Normal environmental conditions

This document applies to probe assemblies designed to be safe at least under the following conditions:

- a) altitude up to 2 000 m;
- b) ambient temperature of 5 °C to 40 °C;
- c) maximum relative humidity of 80 % for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C;
- d) applicable POLLUTION DEGREE of the intended environment.

4.4.2 Extended environmental conditions

This document applies to probe assemblies designed to be safe not only in the environmental conditions specified in 4.4.1, but also in any of the following conditions as RATED by the manufacturer of the probe assembly:

- a) outdoor use;
- b) altitude above 2 000 m;
- c) ambient temperatures below 5 °C or above 40 °C;
- d) relative humidity above the levels specified in 4.4.1;
- e) WET LOCATION.

5 Tests

5.1 General

Tests in this document are TYPE TESTS to be carried out on samples of probe assemblies or their parts. Their only purpose is to check that the design and construction ensure conformity to this document. In addition, the ROUTINE TESTS of Annex D shall be performed on the PROBE WIRE.

The probe assembly shall at least meet the requirements of this document. It is permissible to exceed the requirements. If, in this document, a lower limit is specified for a conformity value, then the probe assembly may demonstrate a larger value. If an upper limit is specified for a conformity value, the probe assembly may demonstrate a lower value. Manufacturing variations and tolerances shall be taken into account.

Tests on components or parts of the probe assembly meeting the requirements of the relevant standards specified in this document, and used in accordance with them, need not be repeated during TYPE TESTS of the whole probe assembly.

If a probe assembly consists of more than one probe type (see 4.1), each type shall be tested in accordance with its applicable requirements.

Conformity to the requirements of this document is checked by carrying out all applicable tests, except that a test may be omitted if examination of the probe assembly and design documentation demonstrates conclusively that it would pass the test. Tests are carried out both under reference test conditions (see 5.3) and fault conditions (see 5.4).

Where conformity statements in this document require inspection, this may include examination of the probe assembly by measurement, examination of the markings on the probe assembly, examination of the instructions supplied with the probe assembly, examination of the data sheets of the materials or components from which the probe assembly is manufactured, etc. In each case, the inspection will either demonstrate that the probe assembly meets the applicable requirements, or will indicate that further testing is required.

If, when carrying out a conformity test, there is any uncertainty about the exact value of an applied or measured quantity (for example voltage) due to the tolerance:

- a) manufacturers should ensure that at least the specified test value is applied;*
- b) test houses should ensure that no more than the specified test value is applied.*

If the RATED range of environmental conditions for probe assemblies is wider than that stated in 4.4.1, the manufacturer should make sure (for example, by suitable alteration of test requirements or additional tests) that the safety requirements of this document are still fulfilled.

Probe assemblies which have undergone TYPE TESTS may no longer be suitable for their intended function because of the residual effect of stresses resulting from tests. A probe assembly which has undergone TYPE TESTS shall not then be put into use.

5.2 Sequence of tests

The sequence of tests is optional unless otherwise specified. The probe assemblies under test shall be carefully inspected after each test. If the result of a test causes doubt as to whether any earlier tests would have passed if the sequence had been reversed, these earlier tests shall be repeated.

5.3 Reference test conditions

5.3.1 Environmental conditions

Unless otherwise specified in this document, the following environmental conditions (but not conflicting with those of 4.4.1) shall exist in the test location:

- a) a temperature of 15 °C to 35 °C;
- b) a relative humidity of not more than 75 %;
- c) an air pressure of 75 kPa to 106 kPa;
- d) no hoarfrost, dew, percolating water, rain, solar irradiation, etc.

5.3.2 State of probe assemblies

Unless otherwise specified, tests shall be carried out on the probe assemblies assembled for NORMAL USE and under the least favourable combination of the conditions given in 5.3.3 to 5.3.9.

In case of doubt, tests shall be performed in more than one combination of conditions.

If dimensions or mass make it unsuitable to carry out particular tests on a complete probe assembly, tests on sub-assemblies are allowed, provided it is verified that the assembled probe assembly will meet the requirements of this document.

5.3.3 Position of the probe assembly

All possible orientations of the probe assembly are considered to be positions of NORMAL USE.

5.3.4 Accessories

Accessories and OPERATOR-interchangeable parts available from, or recommended by, the manufacturer for use with the probe assembly under test shall be either connected or not connected.

5.3.5 Covers and removable parts

Covers or parts which can be removed without using a TOOL shall be removed or not removed whichever is the worst condition.

5.3.6 Input and output voltages

Input and output voltages, including floating voltages shall be set to any voltage within the RATED voltage range.

5.3.7 Controls

Controls which the OPERATOR can adjust without the use of a TOOL shall be set to any position except for combinations of settings prohibited by the manufacturer's marking on the probe assembly.

5.3.8 Connections

The probe assembly shall be connected for NORMAL USE or not connected whichever is the worst condition.

5.3.9 Short-term or intermittent operation

Probe assemblies for short-term or intermittent operation shall be operated for the longest RATED period and shall have the shortest RATED recovery period consistent with the manufacturer's instructions.

5.4 Testing in SINGLE FAULT CONDITION

5.4.1 General

The following requirements apply:

- a) examination of the probe assembly and its circuit diagram will generally show the fault conditions which are liable to result in HAZARDS and which, therefore, shall be applied;
- b) fault tests shall be made as specified for checking conformity, unless it can be demonstrated that no HAZARD could arise from a particular fault condition;
- c) the probe assembly shall be operated under the least favourable combination of reference test conditions (see 5.3). These combinations may be different for different faults and they shall be recorded for each test.

5.4.2 Application of fault conditions

5.4.2.1 General

Fault conditions shall include those specified in 5.4.2.2 to 5.4.2.4. They shall be applied only one at a time and shall be applied in turn in the most convenient order. Multiple simultaneous faults shall not be applied unless they are a consequence of an applied fault.

After each application of a fault condition, the probe assembly or part shall pass the applicable tests of 5.4.4.

5.4.2.2 PROTECTIVE IMPEDANCE

The following requirements apply:

- a) if a PROTECTIVE IMPEDANCE is formed by a combination of components, each component shall be short-circuited or disconnected, whichever is less favourable;
- b) if a PROTECTIVE IMPEDANCE is formed with a single component that meets the requirements of 7.4.5, it need not be short-circuited or disconnected.

5.4.2.3 Probe assemblies or parts for short-term or intermittent operation

Probe assemblies or parts for short-term or intermittent operation shall be operated continuously if continuous operation could occur in a SINGLE FAULT CONDITION.

5.4.2.4 Outputs

Outputs of Type B ~~and Type C~~ probe assemblies shall be short-circuited.

~~4.4.2.5 Insulation between circuits and parts~~ 19

~~Insulation between circuits and parts which is below the level specified for BASIC INSULATION shall be bridged to check against the spread of fire if the method of 9.1 is used.~~

5.4.3 Duration of tests

The probe assembly shall be operated until the point when it is unlikely that further change as a result of the applied fault ~~is unlikely~~ will occur. Each test is normally limited to 1 h since a secondary fault arising from a SINGLE FAULT CONDITION will usually manifest itself within that time. If there is an indication that a HAZARD of electric shock, ~~spread of fire~~ or injury to persons may eventually occur, the test shall be continued for a maximum period of 4 h.

5.4.4 Conformity after application of fault conditions

5.4.4.1 Electric shock

Conformity with requirements for protection against electric shock after the application of single faults is checked as follows:

- a) *by making the measurements of 7.3.3 to check that no ACCESSIBLE conductive parts have become HAZARDOUS LIVE, except as permitted by 7.1;*
- b) *by performing a voltage test on DOUBLE INSULATION, REINFORCED INSULATION or BASIC INSULATION plus impedance 20 when the impedance is short-circuited to check that the protection is still at least at the level of BASIC INSULATION. The voltage tests are made as specified in 7.6 (without humidity preconditioning) with the test voltage for BASIC INSULATION;*
- c) *by inspection and measurements of the SPACINGS for the levels of BASIC INSULATION. This also applies to impedance or PROTECTIVE IMPEDANCE.*

5.4.4.2 Temperature

Conformity with requirements for temperature protection is checked by determining the temperature of the outer surface of the probe assembly (see Clause 10).

This temperature is determined by measuring the temperature rise of the surface or part and adding it to the ambient temperature of 40 °C, or to the maximum RATED ambient temperature, if higher.

~~4.4.4.3 Spread of fire~~ 21

~~Conformity with requirements for protection against the spread of fire is checked by placing the probe assembly on white tissue paper covering a softwood surface and covering the surface~~

~~assembly with cheesecloth. No molten metal, burning insulation, flaming particles, etc. shall fall on the surface on which the probe assembly stands and there shall be no charring, glowing, or flaming of the tissue paper or cheesecloth. Melting of insulation material shall be ignored if no HAZARD could arise.~~

5.4.4.3 Other HAZARDS

Conformity with the requirements for protection against other HAZARDS is checked as specified in Clause 8 to Clause 13.

5.5 Tests in REASONABLY FORESEEABLE MISUSE

5.5.1 General

Tests needed to support a risk assessment pertaining to REASONABLY FORESEEABLE MISUSE are carried out in the combinations of conditions and operations determined during the risk assessment.

5.5.2 Fuses

Fused probe assemblies are used where insufficient protection may be provided by the equipment to which the hand manipulated probe assemblies are connected in particular under the REASONABLY FORESEEABLE MISUSE conditions associated with the equipment that could lead to fire or arc ~~explosion~~ flash.

For the purposes of this test, it is assumed that the equipment to which the probe assemblies are connected represents a short circuit condition. It is further assumed that the fused probe assembly may be connected to any voltage source within the RATING of the probe assembly. This leads to a test condition where any current level up to the maximum prospective short circuit current may be applied. With respect to prospective short circuit currents associated with mains installations, the fuse shall be RATED according to 12.2 and no additional testing related to the interrupt current RATING is necessary. However, testing is necessary at current levels near the RATING of the fuse which could potentially lead to excessive temperature rise on hand-held parts as well as damage to insulating parts, ENCLOSURES, and barriers.

It shall be demonstrated that the maximum fuse temperature under any current load condition up to 5 times the fuse RATING through the fused probe assembly does not lead to a HAZARD.

Conformity is checked by inspection and measurement.

6 Marking and documentation

6.1 Marking

6.1.1 General

Probe assemblies shall bear markings in accordance with 6.1.2 to 6.2. Markings applying to a probe assembly as a whole shall not be put on parts which can be removed by an OPERATOR without the use of a TOOL, *except for removable parts of PROBE TIPS if they comply with 13.2.* **22**

Letter symbols for quantities and units shall be in accordance with IEC 60027-1:1992, IEC 60027-1:1992/AMD1:1997, and IEC 60027-1:1992/AMD2:2005, IEC 60027-2:2019 and IEC 60027-4:2006. Graphical symbols shall be in accordance with Table 1, if applicable. There are no requirements for size or colour. If there is no applicable symbol in Table 1, any other graphical symbol may be used on a probe assembly provided the symbol is explained in the accompanying documentation (see 6.4.1).

If it is not possible to put all of the required markings on the part, the necessary information shall be included in the documentation specified in 6.4.1. Symbol 7 of Table 1 ~~may~~ shall also be used.

Conformity is checked by inspection.

6.1.2 Identification

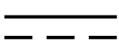
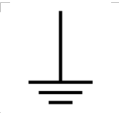
Each probe assembly and, when possible, its accessories shall be marked with:

- a) the name or registered trademark of the manufacturer or supplier;
- b) in addition for Type B ~~and Type C~~ only, the model number or name or other means of identifying the probe assembly or part.

If a probe assembly is designed for use only with a specific model of equipment, this shall be made clear, and the specific equipment or model shall be identified, either by marking on the probe assembly or in the accompanying documentation.

Conformity is checked by inspection.

Table 1 – Symbols

Number	Symbol	Reference	Description
1		IEC 60417-5031 (2002-10)	Direct current
2		IEC 60417-5032 (2002-10)	Alternating current
3		IEC 60417-5033 (2002-10)	Both direct and alternating current
4		IEC 60417-5017 (2006-08)	Earth (ground) TERMINAL
5		IEC 60417-6042 (2010-11)	Caution, ~~possibility~~ risk of electric shock
6		IEC 60417-5041 (2002-10)	Caution, hot surface
7		ISO 7000-0434A (2004-01) or ISO 7000-0434B (2004-01)	Caution ^a
^a See 6.4.1 which requires manufacturers to state that documentation must be consulted in all cases where this symbol is marked.			

6.1.3 Fuses

Probe assemblies which contain fuses intended to be replaced by an OPERATOR shall be marked with all the details necessary for the OPERATOR to obtain the correct fuse. These shall include the voltage RATING and the breaking capacity (the maximum current that the fuse can safely interrupt at the highest RATED voltage). If there is not sufficient ~~room~~ space to mark these details, symbol 7 of Table 1 shall be marked on the probe assembly and the necessary information shall be included in the documentation.

Conformity is checked by inspection.

6.1.4 CONNECTORS and operating devices

If necessary for safety purposes, an indication shall be given of the purpose of CONNECTORS, TERMINALS, and controls, including any sequence of operations.

Conformity is checked by inspection.

6.1.5 RATING

The RATING of probe assemblies shall be marked as follows:

- a) probe assemblies which do not have a RATING for MEASUREMENT CATEGORIES ~~II, III, or IV (see 6.5.1.3)~~ shall be marked with the RATED voltage to earth and with symbol 7 of Table 1 (see also 6.4.3 k));
- b) probe assemblies for measurements within MEASUREMENT CATEGORIES II, III and IV ~~(see 6.5.1.3)~~ shall be marked with the RATED ~~voltages to earth~~ AC RMS line-to-neutral or DC voltage **23** and the relevant MEASUREMENT CATEGORIES.

The MEASUREMENT CATEGORY markings shall be "CAT II", "CAT III" or "CAT IV" as applicable.

NOTE CLEARANCES and solid insulation are specified for nominal AC RMS line-to-neutral or DC voltages of mains being measured. Neutral is considered to be earthed (see Annex H).

If it is possible (see 6.1.1), marking on a probe assembly shall ~~preferably~~ be on the probe body. The nature of the voltage (AC, DC, etc.) shall also be marked, unless the voltage marking applies to both AC RMS and DC. If a REFERENCE CONNECTOR is intended for connection to points at a voltage level exceeding the values of 7.3.2, the RATED voltage to earth shall be marked on the CONNECTOR or as close to the CONNECTOR as is practicable.

For Type A, Type D and Type E probe assemblies only, the RATED current of the probe assembly shall be marked together with the RATED voltage ~~to earth~~. The RATED current does not need to be marked on probe assemblies which are specified for use only in conjunction with equipment which has high-impedance inputs or limited-current outputs.

Conformity is checked by inspection.

6.2 Warning markings

Warning markings shall be legible when the probe assembly is ready for NORMAL USE.

If it is necessary for the OPERATOR to refer to the instruction manual to preserve the protection afforded by the probe assembly, the probe assembly shall be marked with symbol 7 of Table 1. If a warning applies to a particular part of the probe assembly, the marking shall be placed on or near this part.

If the instructions for use state that an OPERATOR is permitted to gain access, using a TOOL, to any part which in NORMAL USE may be HAZARDOUS LIVE, there shall be a warning marking which states that the probe assembly must be isolated or disconnected from the HAZARDOUS LIVE

voltage before access, or symbol 7 of Table 1 may be used provided that the information is included in the instructions for use.

Unless their heated state is self-evident or is obvious from the function of the probe assembly, parts which are easily touched and are also permitted by Clause 10 to exceed the temperature limits shall be marked with symbol 6 of Table 1.

Conformity is checked by inspection.

6.3 Durability of markings

Required markings shall remain clear and legible under conditions of NORMAL USE and shall resist the effects of cleaning agents specified by the manufacturer (see 11.1).

Conformity is checked by performing the following test for durability of markings on the outside of the probe assembly. The markings are rubbed by hand, without undue pressure, for 30 s with a cloth soaked with each specified cleaning agent, one at a time, or, if not specified, with a solution containing a minimum of 70 % isopropyl alcohol in water.

After the above treatment the markings shall be clearly legible and adhesive labels shall not have worked loose or become curled at the edges.

6.4 Documentation

6.4.1 General

Probe assemblies shall be accompanied by documentation when necessary for safety purposes. Such documentation shall include as a minimum:

- a) technical specification;
- b) instructions for use;
- c) name and address of manufacturer or supplier from whom technical assistance may be obtained;
- d) the information specified in 6.4.2 to 6.4.4.

If applicable, warning statements and a clear explanation of warning symbols marked on the probe assembly shall be provided in the documentation or shall be durably and legibly marked on the probe assembly. In particular, there shall be a statement that documentation ~~needs to~~ **must** be consulted in all cases where symbol 7 of Table 1 is used, in order to find out the nature of the potential HAZARD and any actions which have to be taken.

Conformity is checked by inspection.

6.4.2 Probe assembly RATING

Documentation shall include the voltage and current RATING as appropriate, and the MEASUREMENT CATEGORY as well as a statement of the range of environmental conditions for which the probe assembly is designed (see 4.4).

Conformity is checked by inspection.

6.4.3 Probe assembly operation

Instructions for use shall include, if applicable:

- a) identification of operating controls and their use in all operating modes;
- b) for probe assemblies designed for use only with a specific model of equipment, a clear identification of the equipment;

- c) an explanation of symbols related to safety which are used on the probe assembly;
- d) a definition of the relevant MEASUREMENT CATEGORY if marking is required on the probe assembly (see 6.1.5);
- e) a specification of limits for intermittent operation, if applicable;
- f) instructions for interconnection to accessories and other equipment, including indication of suitable accessories, detachable parts and any special materials;
- g) instructions for cleaning;
- h) instructions for replacement of consumable materials;
- i) for probe assemblies which do not have PROBE WIRE with a wear indicator, instructions to periodically inspect the PROBE WIRE;
- j) for probe assemblies which do have PROBE WIRE with a wear indicator, a warning not to use the probe assembly if the wear indicator has become visible (see 12.3.2);
- k) for probe assemblies which do not have a RATING for MEASUREMENT CATEGORIES ~~II, III, or IV~~, a warning not to use the probe assemblies for measurements on mains circuits;
- l) for Type B probe assemblies **RATED for voltages above 1 000 V AC RMS or 1 500 V DC**, if the RATED voltage of the PROBE WIRE is lower than the RATED voltage of the PROBE TIP, a warning that the PROBE WIRE ~~may~~ **will** not provide adequate protection if it comes into contact with a HAZARDOUS LIVE part;
- m) a warning that the applicable MEASUREMENT CATEGORY of a combination of a probe assembly and an accessory is the lowest of the MEASUREMENT CATEGORIES of the probe assembly and of the accessory.

There shall be a statement in the instructions that, if the probe assembly is used in a manner not specified by the manufacturer, the protection provided by the probe assembly may be impaired.

Conformity is checked by inspection.

6.4.4 Probe assembly maintenance and service

Instructions shall be provided to the RESPONSIBLE BODY in sufficient detail to permit safe maintenance and inspection of the probe assembly, and to ensure continued safety of the probe assembly after the maintenance and inspection procedure.

The manufacturer shall specify any parts which are required to be examined or supplied only by the manufacturer or its agent.

The RATING and characteristics of fuses used shall be stated (see 6.1.3).

Instructions on the following subjects shall be provided for service personnel, as necessary to permit safe servicing and continued safety of the probe assembly after servicing if the probe assembly is suitable to be serviced:

- a) product-specific risks that may affect the service personnel;
- b) protective measures for these risks;
- c) verification of the safe state of the probe assembly after repair.

Instructions for service personnel do not need to be supplied to the RESPONSIBLE BODY, but should be made available to service personnel.

Conformity is checked by inspection.

7 Protection against electric shock

7.1 General

Protection against electric shock shall be maintained in NORMAL CONDITION and in SINGLE FAULT CONDITION. ACCESSIBLE parts of probe assemblies shall not be HAZARDOUS LIVE (see 7.3).

If it is not feasible for operating reasons to prevent the following parts from being both ACCESSIBLE and HAZARDOUS LIVE, they are permitted to be ACCESSIBLE to the OPERATOR during NORMAL USE while they are HAZARDOUS LIVE:

- a) parts intended to be replaced by the OPERATOR (for example, fuses) and which may be HAZARDOUS LIVE during replacement, but only if they have warning markings in accordance with 6.2;
- b) PROBE TIPS, provided that they meet the requirements of 7.4.3;
- c) unmated CONNECTORS as specified in 7.4.2.4 1).

Conformity is checked by the determination of 7.2 and the measurements of 7.3, followed by the inspection and tests of 7.4 to 7.7.

7.2 Determination of ACCESSIBLE parts

7.2.1 General

Unless obvious, determination of whether a part is ACCESSIBLE is made as specified in 7.2.2 and 7.2.3. Test fingers (see Figure B.1 and Figure B.2 of Annex B) and pins are applied without force. Parts are considered to be ACCESSIBLE if they can be touched with any part of a test finger or pin, or if they could be touched in the absence of a covering which is not considered to provide suitable insulation (see 7.7.2).

If in NORMAL USE an OPERATOR is intended to perform any actions (with or without a TOOL) that could increase the accessibility of parts, such actions are taken before performing the examinations of 7.2.2 and 7.2.3.

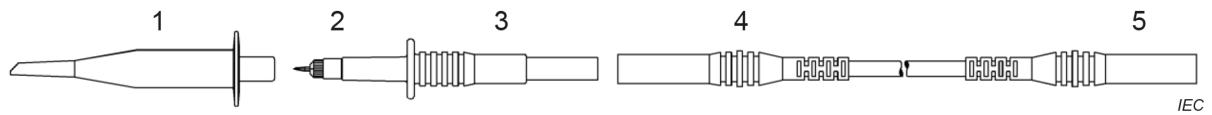
NOTE Examples of such actions include:

- a) removing covers;
- b) adjusting controls;
- c) replacing consumable materials;
- d) removing or installing parts and supplied accessories.

Figure 7 gives methods for determination of ACCESSIBLE parts of probe assemblies.

7.2.2 Examination

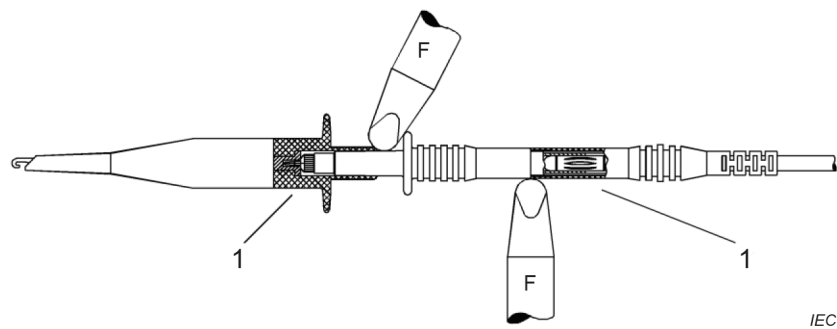
The jointed test finger (see Figure B.2) is applied in every possible position without force. The test is applied to all outer surfaces.



Key

- | | | | |
|---|------------------------------|---|------------------------|
| 1 | accessory PROBE TIP | 4 | CONNECTOR |
| 2 | PROBE TIP | 5 | CONNECTOR to equipment |
| 3 | hand-held area of probe body | | |

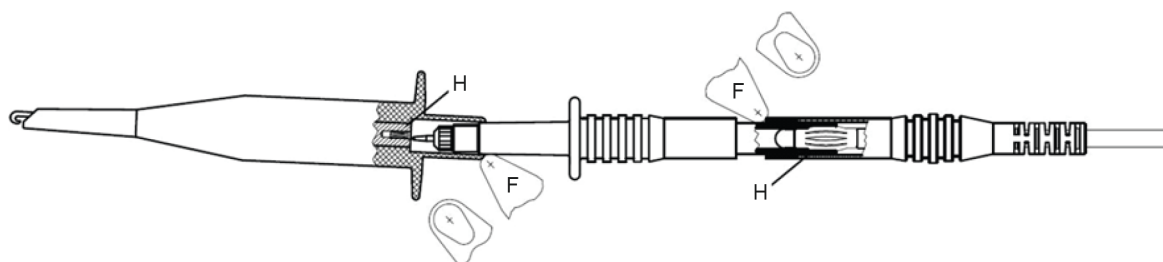
Figure 7 a) – Parts of a probe assembly



Key

- | | |
|---|--------------------------------------|
| 1 | CONNECTOR |
| F | jointed test finger (see Figure B.2) |

Figure 7 b) – Fully mated probe assembly (see 7.4.2.2)



IEC

Key

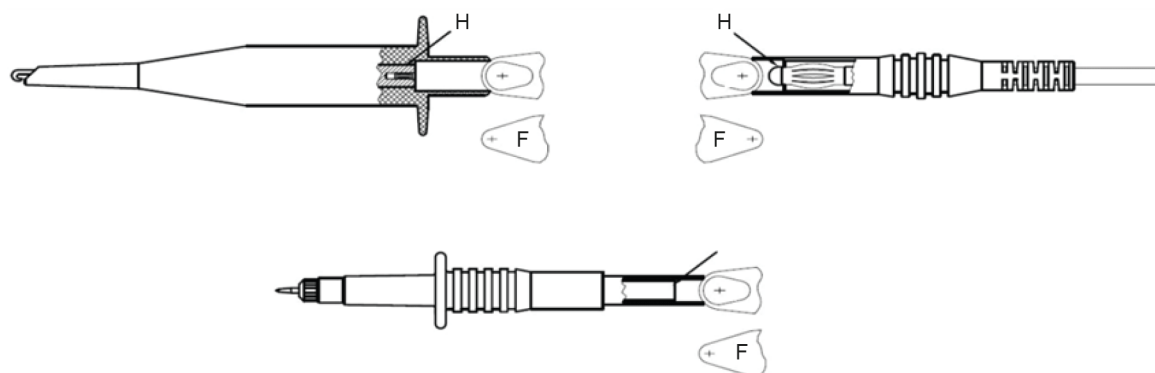
F jointed test finger (see Figure B.2)

H potentially HAZARDOUS LIVE part

Connecting parts are partially mated so as just to make electrical contact while allowing maximum access to the test finger.

Note the two possible positions of the test finger.

Figure 7 c) – Partially mated probe assemblies (see 7.4.2.3)



IEC

Key

F jointed test finger (see ~~Figure B.1~~ Figure B.2)

H potentially HAZARDOUS LIVE part

Note the two possible positions of the test finger.

Figure 7 d) – Unmated parts of a probe assembly (see 7.4.2.4)

Figure 7 – Methods for determination of ACCESSIBLE parts ~~(see 6.2)~~ and for voltage tests of ~~(see 6.4.2)~~

7.2.3 Openings for pre-set controls

A metal test pin 3 mm in diameter is inserted through holes intended to give access to pre-set controls which require the use of a screwdriver or other TOOL. The test pin is applied in every possible direction through the hole. Penetration shall not exceed three times the distance from the ENCLOSURE surface to the control shaft or 100 mm, whichever is smaller.

7.3 Limit values for ACCESSIBLE parts

7.3.1 General

Except as permitted in 7.1, the voltage between an ACCESSIBLE part and earth, or between any two ACCESSIBLE parts on the same probe assembly, shall not exceed the levels of 7.3.2 in NORMAL CONDITION or of 7.3.3 in SINGLE FAULT CONDITION.

Outer conductors (shields) of probe assemblies, intended to be floating, are considered to be held at the same voltage as the PROBE TIP.

The ACCESSIBLE voltage shall be measured (see 7.3.4). If the voltage is below the levels of 7.3.2 a) or 7.3.3 a) as applicable, the touch current and the capacitance need not be measured. If the voltage exceeds that level, the touch current and the capacitance shall be measured. For high frequencies test probes **RATED for frequencies above 100 kHz**, the alternative method of 7.3.4.3 can also be used.

Conformity is checked by inspection and as specified in 7.3.2, 7.3.3 and 7.3.4.

7.3.2 Levels in NORMAL CONDITION

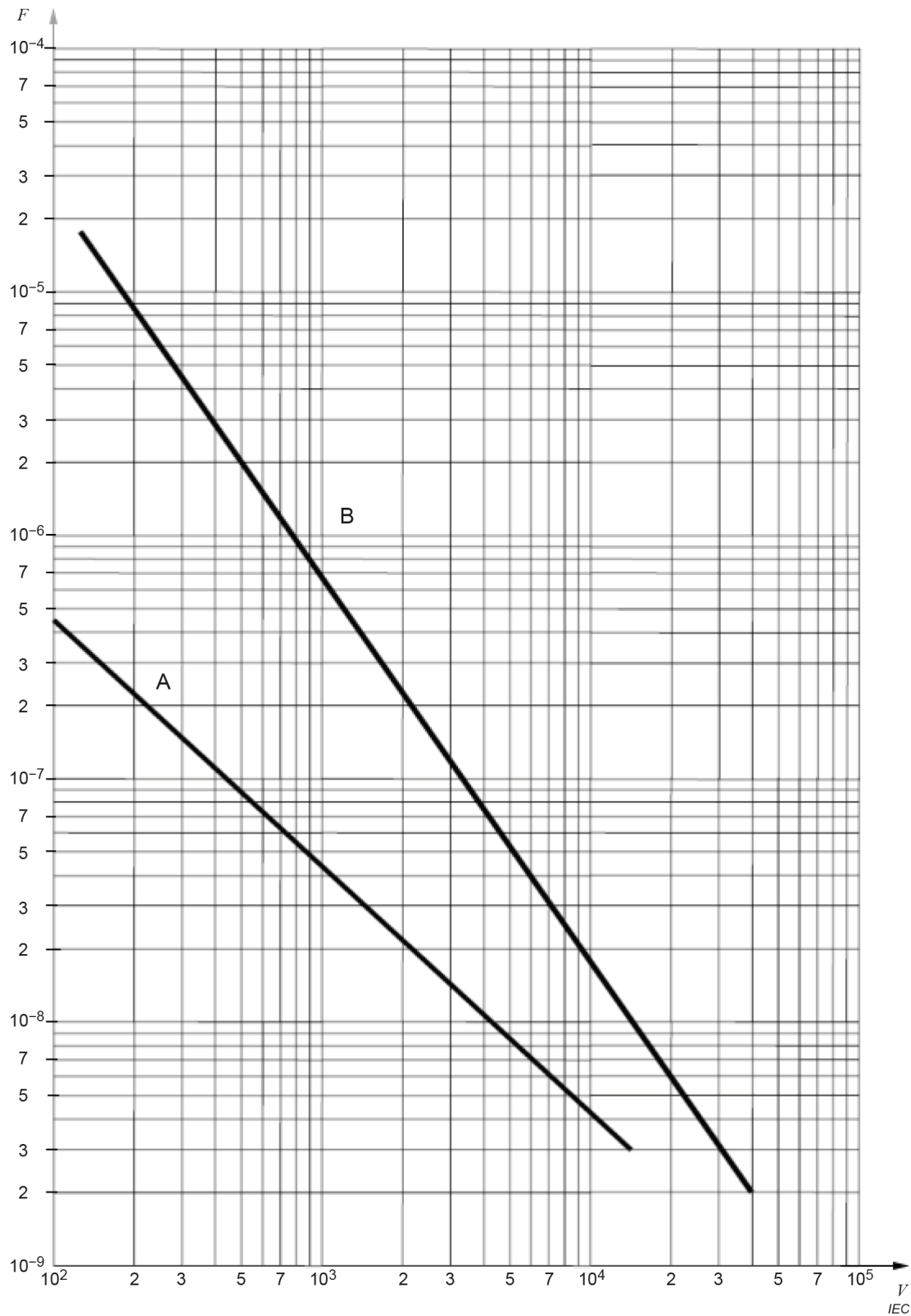
Voltages above the levels of 7.3.2 a) are deemed to be HAZARDOUS LIVE if any of the levels of 7.3.2 b) or 7.3.2 c) are exceeded at the same time.

- a) The AC voltage level is 30 V RMS or 42,4 V peak, and the DC voltage level is 60 V. For probe assemblies intended for use in WET LOCATIONS, the AC voltage level is 16 V RMS or 22,6 V peak, and the DC voltage level is 35 V.
- b) The touch current levels are:
 - 1) 0,5 mA RMS for sinusoidal waveforms, 0,7 mA peak for non-sinusoidal waveforms or mixed frequencies, or 2 mA DC, when measured with the measuring circuit of Figure A.1. If the frequency does not exceed 100 Hz, the measuring circuit of Figure A.2 can be used. The measuring circuit of Figure A.5 is used for probe assemblies intended for use in WET LOCATIONS.
 - 2) 70 mA RMS when measured with measuring circuit of Figure A.3. This relates to possible burns at frequencies above 100 kHz.
- c) The levels of capacitive charge or energy are:
 - 1) 45 µC charge for voltages up to 15 kV peak or 15 kV DC. Line A of Figure 8 shows the capacitance versus voltage for cases where the charge is 45 µC.
 - 2) 350 mJ stored energy for voltages above 15 kV peak or 15 kV DC.

7.3.3 Levels in SINGLE FAULT CONDITION

In SINGLE FAULT CONDITION, voltages above the levels of 7.3.3 a) are deemed to be HAZARDOUS LIVE if any of the levels of 7.3.3 b) or 7.3.3 c) are exceeded at the same time.

- a) The AC voltage level is 50 V RMS or 70,7 V peak, and the DC voltage level is 120 V. For probe assemblies intended for use in WET LOCATIONS, the AC voltage level is 33 V RMS or 46,7 V peak, and the DC voltage level is 70 V.
- b) The touch current levels are:
 - 1) 3,5 mA RMS for sinusoidal waveforms, 5 mA peak for non-sinusoidal waveforms or mixed frequencies, or 15 mA DC, when measured with the measuring circuit of Figure A.1. If the frequency does not exceed 100 Hz, the measuring circuit of Figure A.2 can be used. The measuring circuit of Figure A.5 is used for probe assemblies intended for use in WET LOCATIONS.
 - 2) 500 mA RMS when measured with the measuring circuit of Figure A.3. This relates to possible burns at frequencies above 100 kHz.
- c) The capacitance level is line B of Figure 8.



Key

A = NORMAL CONDITION

B = SINGLE FAULT CONDITION

Figure 8 – Capacitance level versus voltage in NORMAL CONDITION and SINGLE FAULT CONDITION (see 7.3.2 c) and 7.3.3 c))

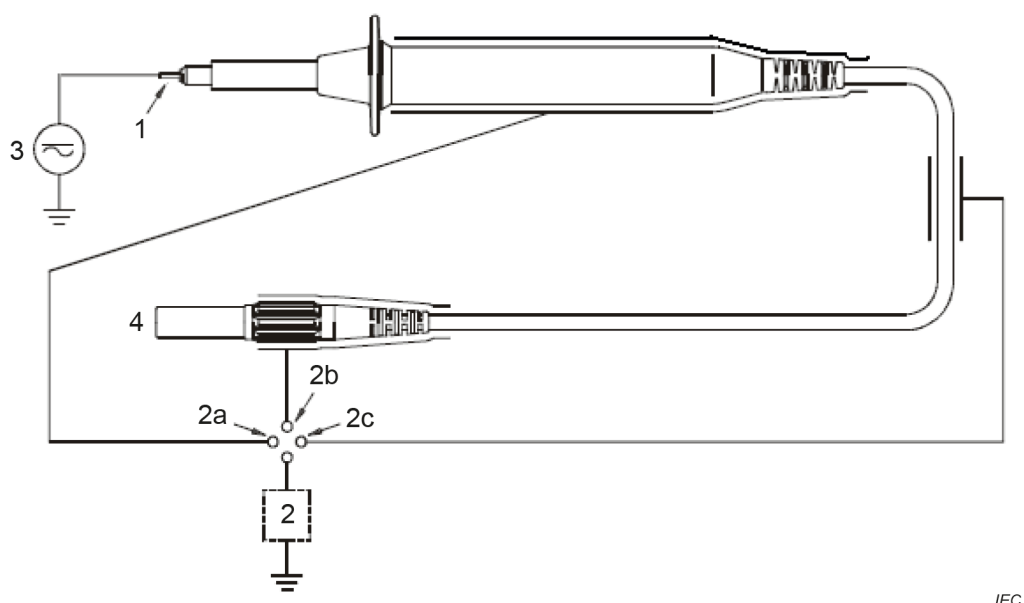
7.3.4 Measurement of voltage and touch current

7.3.4.1 General

Measurement of voltage and touch current on ACCESSIBLE parts of probe assemblies is carried out with metal foil wrapped around each of the following parts, individually:

- the probe body;
- hand-held or hand-manipulated parts of each CONNECTOR;
- 150 mm ± 20 mm of the PROBE WIRE or the maximum length of the cable whichever is shorter;
- other hand-held or hand-manipulated parts.

The **highest** RATED voltage to earth is applied between the PROBE TIP (1) and the earth. The voltage is measured between the foil and the earth. If necessary, the measurement circuit is connected in turn (2a, then 2b, and then 2c of Figure 9) between each of the foil-wrapped items and the earth (see Figure 9 and Figure 10).

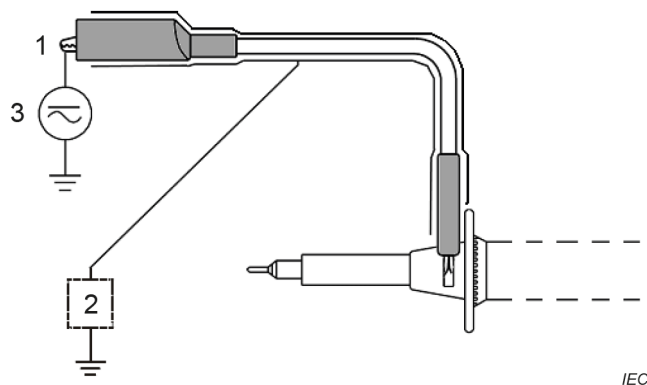


IEC

Key

- PROBE TIP
- measurement of voltage or touch current (see Annex A for applicable measuring circuits for touch current measurements)
 - connection to metal foil tightly wrapped around parts intended to be hand-held or hand-manipulated
 - connection to metal foil tightly wrapped around the CONNECTOR
 - connection to metal foil tightly wrapped around the cable
- ~~Maximum~~ **highest** RATED voltage with connection to internal conductor of the PROBE WIRE
- not connected to test or measuring equipment

Figure 9 – Voltage and touch current measurement



Key

- 1 PROBE TIP of the REFERENCE CONNECTOR
- 2 measurement of voltage or touch current (see Annex A for applicable measuring circuits for touch current measurements)
- 3 ~~Maximum~~ highest RATED voltage for the REFERENCE CONNECTOR

Figure 10 – Voltage and touch current measurement for the REFERENCE CONNECTOR

7.3.4.2 Probe assemblies with floating outer conductors

For probe assemblies where the outer conductor (shield) connection may be intended to be floating, the test is also performed between the outer conductor PROBE TIP (Figure 11, item 5) and the earth (see Figure 11).

The touch current is determined by using the applicable measuring circuit of Annex A.

NOTE In practice for the calculation with frequencies above 100 kHz, the values of R_1 and C_1 can be ignored.

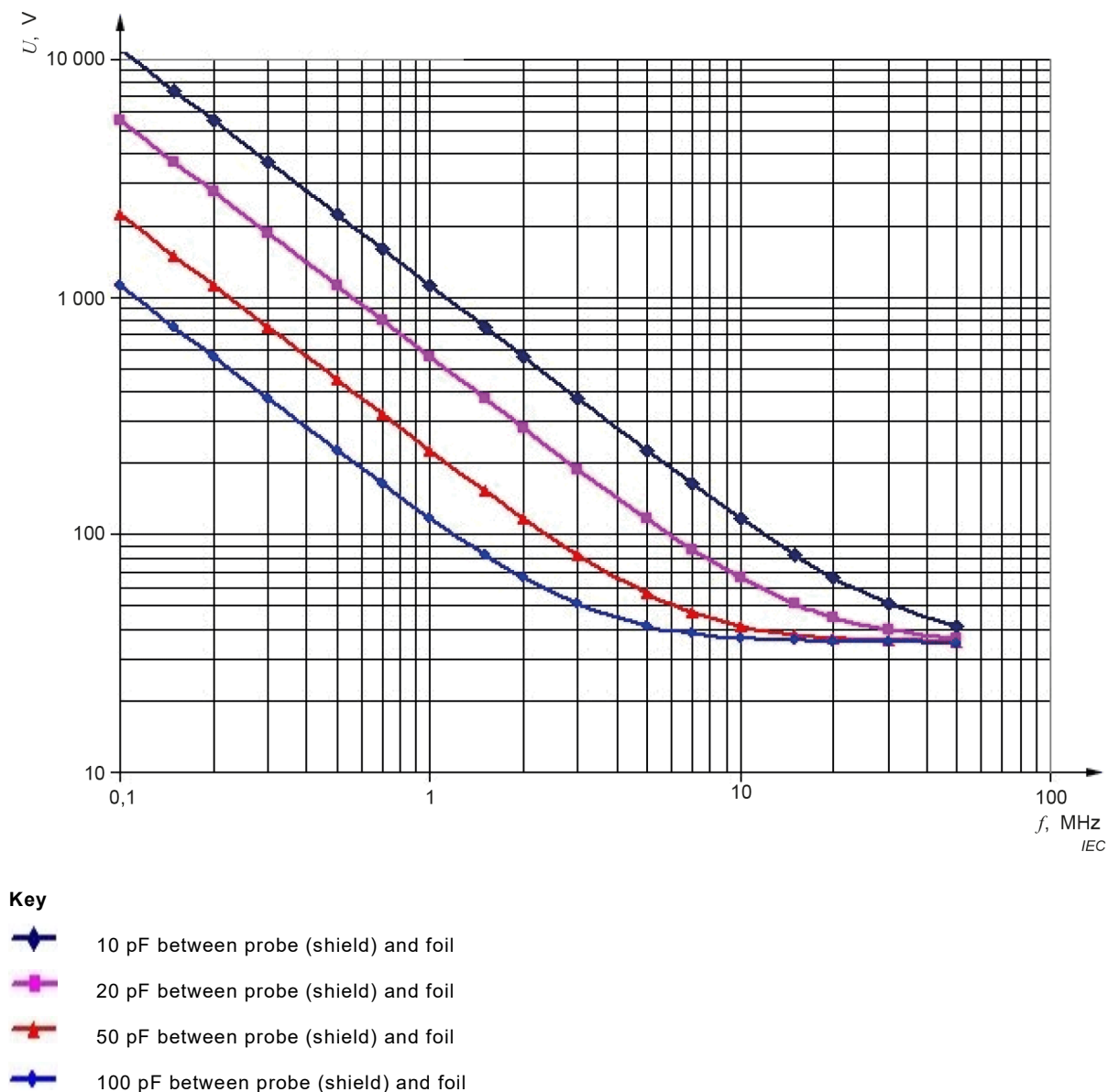


Figure 12 – Maximum test probe input voltage for 70 mA touch current

7.4 Means of protection against electric shock

7.4.1 General

CONNECTORS shall meet the requirements of 7.4.2.

PROBE TIPS shall meet the requirements of 7.4.3.

All other ACCESSIBLE parts of probe assemblies shall be prevented from becoming HAZARDOUS LIVE in both NORMAL CONDITION and SINGLE FAULT CONDITION by one or more of the following means:

- A) BASIC INSULATION plus impedance (see 7.4.4);
- B) PROTECTIVE IMPEDANCE (see 7.4.5);
- C) DOUBLE INSULATION, consisting of BASIC INSULATION plus SUPPLEMENTARY INSULATION (see 7.4.6);

D) REINFORCED INSULATION (see 7.4.6).

NOTE The PROBE WIRE is considered to be hand-held. See also Clause 12 for requirements pertaining to the PROBE WIRE.

Conformity is checked by inspection and as specified in 7.4.2 to 7.4.6, as applicable.

7.4.2 CONNECTORS**7.4.2.1 General**

Insulation, ACCESSIBLE parts and SPACINGS for CONNECTORS of probe assemblies shall meet the applicable requirements of 7.4.2.2 to 7.4.2.4. When a CONNECTOR is intended to mate with another CONNECTOR or a TERMINAL having different RATINGS, the lower RATING applies. 24

Insulation covers or sleeves over CONNECTORS which are intended to be hand-held or hand-manipulated by the OPERATOR during measurement or test, and which can be removed or displaced by the OPERATOR without the use of a TOOL, are not considered to provide the required protection against electric shock except when they are needed for connection to test or measurement equipment that is equipped with TERMINALS which cannot accept fully shrouded CONNECTORS. For example, retractable insulation sleeves are not considered to provide adequate protection.

Annex E provides information regarding the recommended dimensions of 4 mm CONNECTORS up to 1 000 V.

Conformity is checked by inspection.

7.4.2.2 CONNECTORS in fully mated position

- a) ACCESSIBLE parts of CONNECTORS used only for connecting the probe assembly to the test or measurement equipment and which are not intended to be hand-held during the measurement operation shall be insulated from HAZARDOUS LIVE parts by BASIC INSULATION.
- b) ACCESSIBLE parts of CONNECTORS which are used for any other purpose or which are intended to be hand-held during the measurement operation shall be insulated from HAZARDOUS LIVE parts by DOUBLE INSULATION or REINFORCED INSULATION.

Conformity is checked by the determination of ACCESSIBLE parts as specified in 7.2 (see Figure 7 b) and as specified in 7.4.6 for BASIC INSULATION and REINFORCED INSULATION.

7.4.2.3 CONNECTORS in partially mated position

ACCESSIBLE parts of CONNECTORS in partially mated ~~condition~~ position shall be insulated from HAZARDOUS LIVE parts by BASIC INSULATION.

Conformity is checked by the determination of ACCESSIBLE parts as specified in 7.2 (see Figure 7 c) and as specified in 7.4.6 for BASIC INSULATION.

7.4.2.4 CONNECTORS in unmated position

When RATED voltages ~~to earth~~ are applied to other CONNECTORS or to PROBE TIPS of the probe assembly, the following requirements apply to CONNECTORS in unmated position.

- ~~1) conductive parts of locking type or screw held type CONNECTORS including CONNECTORS which do not require the use of a TOOL for unlocking or unscrewing are permitted to be ACCESSIBLE while they are in unmated position;~~
- ~~2) unmated integrated TERMINALS of STACKABLE CONNECTORS shall be protected by BASIC INSULATION (see Figure 5);~~

3) ~~Conductive parts of other unmated CONNECTORS shall be prevented from becoming HAZARDOUS LIVE by PROTECTIVE IMPEDANCE (see 6.4.5) or shall have SPACINGS meeting the following requirements:~~

- ~~i) for unmated CONNECTORS with voltage RATING up to 1 000 V a.c. or 1 500 V d.c., the applicable SPACINGS of Table 2 from the closest approach of the test finger touching the external parts of the CONNECTOR in the least favorable position (see Figure 6 d), or~~
- ~~ii) for unmated CONNECTORS with voltage RATING exceeding 1 000 V a.c. or 1 500 V d.c., the SPACINGS shall not be less than 2.8 mm and shall withstand the voltage test of 6.6 with a test voltage equal to the RATED voltage of the CONNECTOR multiplied by 1,25.~~

Table 2 – SPACINGS for unmated CONNECTORS RATED up to 1 000 V a.c. or 1 500 V d.c. with HAZARDOUS LIVE conductive parts

Voltage on conductive parts of CONNECTOR	SPACING
V a.c. r.m.s. or V d.c.	mm
$> 30 \leq 300$	0,8
$> 300 \leq 600$	1,0
$> 600 \leq 1\,000$	2,6
$> 1\,000 \leq 1\,500^a$	2,8
^a — only for d.c. voltage	

~~Conformity is checked by inspection, by measuring the current or voltage to confirm that they do not exceed the applicable levels of 6.3, by the determination of ACCESSIBLE parts as specified in 6.2 (see Figure 6 c)) and measuring the applicable SPACINGS, and if applicable, the voltage test of 6.6.~~

~~Insulation covers or sleeves over CONNECTORS which are intended to be hand-held or hand-manipulated by the OPERATOR during measurement or test, and can be removed or displaced by the OPERATOR without the use of a TOOL, are not considered to provide the required protection against electric shock. For example, retractable insulation sleeves are not considered to provide adequate protection. The only case in which they are acceptable is where they are needed for connection to test or measurement equipment that is equipped with TERMINALS which cannot accept fully shrouded CONNECTORS.~~

~~Conformity is checked by inspection.~~

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

Conformity is checked by inspection.

- 2) ACCESSIBLE parts of unmated integrated TERMINALS of STACKABLE CONNECTORS shall be insulated from HAZARDOUS LIVE parts by BASIC INSULATION.

Conformity is checked by the determination of ACCESSIBLE parts as specified in 7.2 (see Figure 7 d) for the part defined by key 1 of Figure 1 and measurement of the CLEARANCES as specified in 7.5.2 for BASIC INSULATION.

- 3) ACCESSIBLE parts of other unmated CONNECTORS shall be insulated from HAZARDOUS LIVE parts by PROTECTIVE IMPEDANCE (see 7.4.5) or SPACINGS meeting the requirements of a) and b) below.

- a) For CONNECTORS with a voltage RATING up to 20 kV **25**, the CLEARANCE shall be at least the applicable value of Table 2.

Table 2 – CLEARANCES for unmated CONNECTORS

Maximum voltage applied to the conductive parts of the CONNECTORS V	CLEARANCE	
	AC RMS mm	DC mm
600	0,8	0,8
1 000	1,0	0,8
1 500	2,0	1,1
2 000	3,2	1,8
3 000	6,4	3,5
5 000	13	8,3
10 000	30	20
15 000	48	32
20 000	67	44
For maximum voltages above 30 V AC RMS or 60 V DC up to 600 V, CLEARANCES are 0,8 mm. Linear interpolation is allowed above 600 V. NOTE See Annex G.		

For CONNECTORS with a RATING above 20 kV, the CLEARANCE shall be at least the D_2 value of Table 5 with U_m equal to 1,25 times the peak value of the RATED voltage (see 7.5.2.3.2).

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

Conformity is checked by one of the following tests:

- i) the determination of ACCESSIBLE parts as specified in 7.2 (see Figure 7 d)) and the measurement of the CLEARANCE, or
- ii) the AC voltage test of 7.6.5.1 or the DC voltage test of 7.6.5.2 for probe assemblies stressed only by DC with a duration of at least 5 s, or the impulse voltage test of 7.6.5.3, using the test voltage of Table 11 for the required CLEARANCE. **26**

Correction factors of Table 12 are applicable to the values of the test voltages for CLEARANCES given in Table 11.

- b) The CREEPAGE DISTANCE values shall be at least the applicable CLEARANCE values defined in a). **27**

Conformity is checked by determination of ACCESSIBLE parts as specified in 7.2 (see Figure 7 d)) and measurement of the CREEPAGE DISTANCE.

7.4.3 PROBE TIPS

7.4.3.1 General

PROBE TIPS that can become HAZARDOUS LIVE during NORMAL USE (see also 7.1 b)) shall meet the requirements of one of the following subclauses, 7.4.3.2 (if protection by a PROTECTIVE FINGERGUARD), 7.4.3.3 (if protection by distance) or 7.4.3.4 (if protection by tactile indicator). In addition, IP 2X PROBE TIPS with retractable sleeve shall meet the requirements of 7.4.3.5.

PROBE TIPS that can be used as CONNECTORS shall also meet the requirements of 7.4.3.6.

NOTE See Clause 13 for additional requirements for the exposed conductive parts of PROBE TIPS.

SPRING-LOADED CLIPS and similar probes that are intended to pierce the insulation of a wire to touch the conductor for measuring voltage purposes shall not have a voltage RATING above the levels of 7.3.2 a).

Conformity is checked by inspection and measurement.

7.4.3.2 Protection by a PROTECTIVE FINGERGUARD

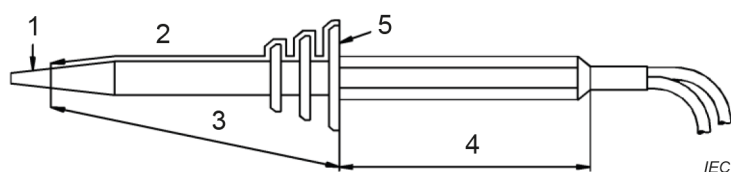
If a conductive part of a PROBE TIP can become HAZARDOUS LIVE, or if the end of a PROBE TIP can touch a HAZARDOUS LIVE conductor, a PROTECTIVE FINGERGUARD shall be fitted to reduce the risk of touching an exposed ~~conductive~~ part of the PROBE TIP, and to provide an indication of the limit beyond which it may be hazardous to touch the probe ~~body~~ ENCLOSURE during use.

SPACINGS between ~~the HAZARDOUS LIVE part of~~ the PROBE TIP and the hand-held side of the PROTECTIVE FINGERGUARD shall be those specified for REINFORCED INSULATION.

The height of the PROTECTIVE FINGERGUARD from the side where the fingers are intended to be applied shall be at least 2 mm.

The PROTECTIVE FINGERGUARD of probe assemblies which have a voltage RATING above the levels of 7.3.2 a) shall extend across at least 80 % of the sides where the fingers are intended to be applied.

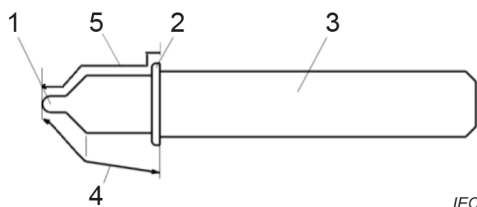
Figure 13 gives examples of probe assemblies with a PROTECTIVE FINGERGUARD and indicates applicable SPACINGS.



Key

- | | | | |
|---|-----------------------------------|---|------------------------------|
| 1 | PROBE TIP | 4 | hand-held area of probe body |
| 2 | CREEPAGE DISTANCE (along surface) | 5 | PROTECTIVE FINGERGUARD |
| 3 | CLEARANCE ~~(in air)~~ | | |

Figure 13 a) – Probe assembly for direct electrical connection



Key

- | | | | |
|---|------------------------------|---|-----------------------------------|
| 1 | PROBE TIP (insulated) | 4 | CLEARANCE |
| 2 | PROTECTIVE FINGERGUARD | 5 | CREEPAGE DISTANCE (along surface) |
| 3 | hand-held area of probe body | | |

Figure 13 b) – Type F probe assembly for non-contact measurement

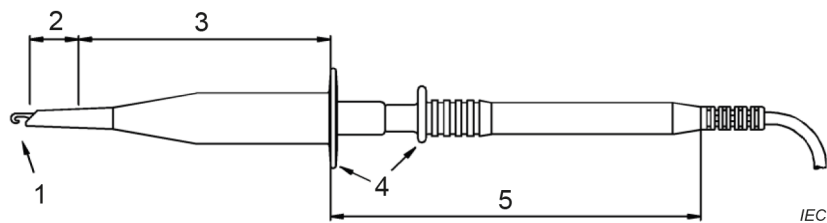
Figure 13 – Protection by a PROTECTIVE FINGERGUARD

7.4.3.3 Protection by distance

SPRING-LOADED CLIPS RATED for voltages ~~to earth~~ up to 1 kV are acceptable without a PROTECTIVE FINGERGUARD provided that:

- a) actuation of the spring-loaded mechanism prevents the OPERATOR from touching a HAZARDOUS LIVE part; and
- b) the SPACINGS between the PROBE TIP and the nearest surface which the OPERATOR needs to touch to actuate the mechanism are increased by an additional protective distance of 45 mm.

Figure 14 gives an example of a probe assembly protected by distance and indicates applicable SPACINGS.



Key

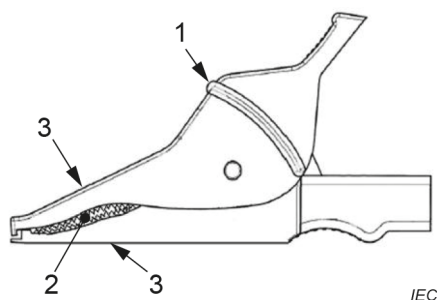
- | | | | |
|---|---|---|--------------------------------------|
| 1 | PROBE TIP | 4 | actuating parts |
| 2 | ~~CLEARANCE AND CREEPAGE DISTANCE~~ SPACINGS as specified in 7.5 | 5 | hand-held area of the probe assembly |
| 3 | additional protective distance | | |

Figure 14 – Protection by distance

7.4.3.4 Protection by tactile indicator

SPRING-LOADED CLIPS RATED for MEASUREMENT CATEGORY II or without MEASUREMENT CATEGORY for maximum 300 V which require finger pressure at about 90° to the axis of the clip are acceptable without a PROTECTIVE FINGERGUARD, provided that there is a tactile indicator to indicate the limit of safe access for the OPERATOR.

EXAMPLE Figure 15 gives an example of a SPRING-LOADED CLIP with a tactile indicator.



Key

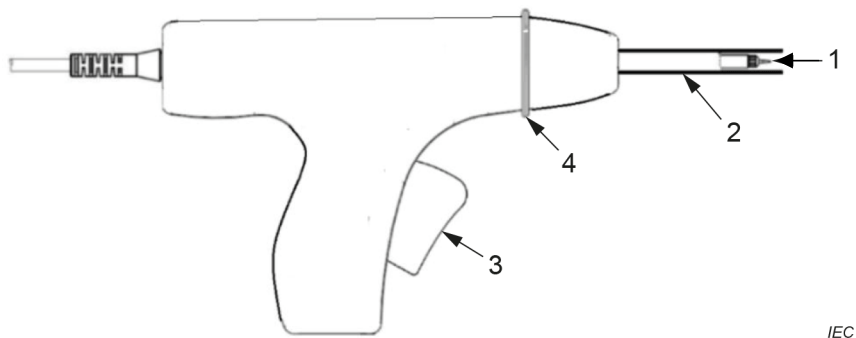
- | | |
|---------------------|------------------------|
| 1 tactile indicator | 3 insulated metal jaws |
| 2 metal jaws | |

Figure 15 – Protection by tactile indicator

7.4.3.5 IP2X PROBE TIPS with retractable sleeve

IP2X probe assemblies are probe assemblies with an IP2X protection of the PROBE TIP. HAZARDOUS LIVE parts of the PROBE TIP with an IP2X degree of protection are prevented by a retractable sleeve from being ACCESSIBLE. In non-operative position, the sleeve covers the PROBE TIP. The sleeve can be retracted voluntarily by pressing on a trigger or by applying a strength force exceeding the value as set out in Table 6 of IEC 60529:1989. When the sleeve is retracted, the OPERATOR's hand holds onto the probe body.

EXAMPLE Figure 16 gives an example of probe assembly with an IP2X PROBE TIP.



Key

- | | |
|----------------------|--------------------------|
| 1 PROBE TIP | 3 trigger |
| 2 retractable sleeve | 4 PROTECTIVE FINGERGUARD |

Figure 16 – Example of probe assembly with IP2X PROBE TIP

IP2X PROBE TIPS with retractable sleeve do not provide particular protection against risk of short circuits.

The conductive parts of PROBE TIPS of IP2X probe assemblies shall not be ACCESSIBLE when the sleeve is in the non-operative position.

Conformity is checked by determination of the ACCESSIBLE parts when performing the test from IEC 60529:1989, 12.2. **28**

7.4.3.6 PROBE TIPS used as CONNECTORS

PROBE TIPS which can be used as CONNECTORS and are intended to be connected to specified accessories (for example to a SPRING-LOADED CLIP) shall, in combination with those accessories, also meet the requirements for CONNECTORS in fully mated position (see 7.4.2.2) and partially mated position (see 7.4.2.3).

7.4.4 Impedance

Impedance used as an additional means of protection in conjunction with BASIC INSULATION shall meet all the following requirements:

- a) it shall limit the current or voltage to not more than the applicable levels of 7.3.3;
- b) it shall be RATED for the WORKING VOLTAGE and for the amount of power that it will dissipate;
- c) SPACINGS between terminations of the impedance shall meet the applicable requirements of 7.5 for BASIC INSULATION.

Conformity is checked by inspection, by measuring the voltage or current to confirm that they do not exceed the levels of 7.3.3, and by measuring ~~CLEARANCE and CREEPAGE DISTANCE~~ SPACINGS as specified in 7.5.

7.4.5 PROTECTIVE IMPEDANCE

A PROTECTIVE IMPEDANCE shall limit the current or voltage to the levels of 7.3.2 in NORMAL CONDITION and to the levels of 7.3.3 in SINGLE FAULT CONDITION (see also 5.4.2.2).

Insulation between the terminations of the PROTECTIVE IMPEDANCE shall meet the requirements of 7.4.6 for ~~DOUBLE INSULATION OF~~ REINFORCED INSULATION.

A PROTECTIVE IMPEDANCE shall be one or more of the following:

- a) an appropriate single component which shall be constructed, selected and tested so that safety and reliability for protection against electric shock is ~~assured~~ ensured. In particular, the component shall be:
 - 1) RATED for twice the WORKING VOLTAGE;
 - 2) if a resistor, RATED for twice the power dissipation for the WORKING VOLTAGE;
 - 3) if a capacitor, RATED for the maximum transient overvoltage;
- b) a combination of components.

When a combination of components is used, the SPACINGS shall take into account the WORKING VOLTAGE across each insulation.

A PROTECTIVE IMPEDANCE shall not be a single electronic device that employs electron conduction in a vacuum, gas or semiconductor.

Conformity is checked by inspection, by measuring the current or voltage to confirm that they do not exceed the applicable levels of 7.3 and by measuring SPACINGS as specified in 7.5. Conformity of a single component is checked by inspection of its RATINGS.

7.4.6 BASIC INSULATION, SUPPLEMENTARY INSULATION, DOUBLE INSULATION and REINFORCED INSULATION

SPACINGS and solid insulation forming BASIC INSULATION, SUPPLEMENTARY INSULATION or REINFORCED INSULATION between ACCESSIBLE parts and HAZARDOUS LIVE parts shall meet the applicable requirements of 7.5.

DOUBLE INSULATION is ~~comprised~~ composed of BASIC INSULATION and SUPPLEMENTARY INSULATION, each of which shall meet the applicable requirements of 7.5.

Conformity is checked as specified in 7.5.

7.5 Insulation requirements

7.5.1 The nature of insulation

~~6.5.1.1 General~~

~~Insulation between circuits and ACCESSIBLE parts (see 6.2) or between separate circuits consists of SPACINGS, solid insulation, or a combination of SPACINGS and solid insulation. SPACINGS comprise both CLEARANCES and CREEPAGE DISTANCES.~~

~~When used to provide protection against a HAZARD, the insulation needs to withstand the electric stresses that are caused by the voltages that may appear on parts of the probe assembly.~~

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 supplies or circuits directly connected to them, 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 be considered by the OPERATOR to ensure that they do not exceed the capabilities of the probe assembly.

The requirements for insulation depend on:

- a) the required level of insulation (BASIC INSULATION, SUPPLEMENTARY INSULATION, or REINFORCED INSULATION);
- b) the maximum transient overvoltage that may appear on the circuit, either as a result of an external event (such as a lightning strike or a switching transient), or as the result of the operation of the probe assembly;
- c) the WORKING VOLTAGE;
- d) the POLLUTION DEGREE of the micro-environment;
- e) insulation between circuits and ACCESSIBLE parts (see 7.2) or between separate circuits consists of SPACINGS, solid insulation, or a combination of SPACINGS and solid insulation.

~~6.5.1.2 SPACINGS~~

~~6.5.1.2.1 General~~

SPACINGS are a combination of CLEARANCES and CREEPAGE DISTANCES, which are specified in 7.5.2 and 7.5.3 so as to withstand the voltages that appear on the system for which the probe assembly is intended. Also, they are selected to take account of the intended environmental conditions and any protective devices fitted within the probe assembly or required by the manufacturer's instructions.

7.5.2 CLEARANCES

7.5.2.1 General

CLEARANCES are specified to withstand the maximum transient overvoltage that can be present on the circuit to which the probe assembly can be connected in NORMAL USE. If transient overvoltages cannot occur, CLEARANCES are based on the WORKING VOLTAGE.

The values for CLEARANCES given in Table 4 and Table 5 are based on absolute inhomogeneous field conditions. Reduced CLEARANCES may apply to constructions which are shaped in a way to create a more homogeneous condition, because the dielectric strength of an air gap is dependent on the shape of the electric field within the gap, as well as on the width of the gap.