

**ANSI/ISA-S82.02.02-1996 (IEC 1010-2-031)**

Approved May 31, 1996

Standard

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# **Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use**

Identical to IEC 1010-2-031:

Particular requirements for hand-held PROBE ASSEMBLIES  
for electrical measurement and test



ANSI/ISA-S82.02.02-1996 (IEC 1010-2-031) — Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

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## Preface

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This preface as well as all footnotes and annexes are included for informational purposes and is not part of ANSI/ISA-S82.02.02-1996 (IEC 1010-2-031).

This standard has been prepared as part of the service of ISA, the international society for measurement and control, toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms and asks that they be addressed to the Secretary, Standards and Practices Board; ISA; 67 Alexander Drive; P. O. Box 12277; Research Triangle Park, NC 27709; Telephone (919) 549-8411; Fax (919) 549-8288; E-mail: Standards@isa.org.

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## Contents

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<b>Preface .....</b>	<b>3</b>
<b>Foreword.....</b>	<b>9</b>
<b>1 Scope and object .....</b>	<b>11</b>
<b>2 Normative references .....</b>	<b>11</b>
<b>3 Definitions .....</b>	<b>12</b>
<b>4 Tests .....</b>	<b>12</b>
<b>5 Marking and documentation .....</b>	<b>13</b>
<b>6 Protection against electric shock .....</b>	<b>17</b>
<b>7 Protection against mechanical hazards .....</b>	<b>26</b>
<b>8 Mechanical resistance to shock, vibration and impact .....</b>	<b>26</b>
<b>9 Equipment temperature limits and protection against the spread of fire.....</b>	<b>28</b>
<b>10 Resistance to heat .....</b>	<b>28</b>
<b>11 Resistance to moisture and liquids .....</b>	<b>29</b>
<b>12 Protection against radiation, including laser sources, and against sonic and ultrasonic pressure .....</b>	<b>29</b>
<b>13 Protection against liberated gases, explosion and implosion .....</b>	<b>29</b>
<b>14 Components .....</b>	<b>30</b>
<b>15 Protection by interlocks .....</b>	<b>30</b>
<b>Annexes .....</b>	<b>31</b>





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## Foreword

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- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international cooperation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. 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. The 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 the IEC on technical matters, prepared by technical committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.
- 3) They have the form of recommendations for international use published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
- 4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
- 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

International Standard 1010-2-0301 has been prepared by IEC technical committee No. 66: Safety of measuring, control, and laboratory equipment.

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

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

DIS	Report on Voting
66E(CO)13	66(CO)53*

\* TC 66 has taken over the scope of SC 66E

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

This Part 2 is intended to be used in conjunction with IEC 1010-1. It was established on the basis of the first edition (1990) and its Amendment 1 (1991). Consideration may be given to future editions of, or amendments to, IEC 1010-1.

This Part 2 supplements or modifies the corresponding clauses in IEC 1010-1 so as to convert that publication into the IEC standard: Safety requirements for hand-held PROBE ASSEMBLIES for electrical measurement and test.

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

In this standard:

the following print types are used:

- requirements: in roman type;
- NOTES: in small roman type;
- *compliance: in italic type;*
- terms used throughout this standard which have been defined in clause 3:

SMALL ROMAN CAPITALS

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## 1 Scope and object

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This clause of part 1 is applicable except as follows:

### 1.1 Scope

#### *Replacement:*

This International Standard applies to hand-held and hand-manipulated PROBE ASSEMBLIES of the types described below, and related accessories. These PROBE ASSEMBLIES are for use in the interface between an electrical phenomenon and a measuring or test instrument. They may be stand-alone PROBE ASSEMBLIES which are themselves within the scope of part 1, or accessories to other equipment within the scope of part 1.

- a) Low-voltage and high-voltage, non-attenuating PROBE ASSEMBLIES (type A).

Non-attenuating PROBE ASSEMBLIES for direct connection to voltages exceeding 63 kV r.m.s. or d.c. They do not incorporate active components, nor are they intended to provide a voltage divider function or a signal conditioning function, but they may contain passive non-attenuating components such as fuses.

- b) High-voltage attenuating or divider PROBE ASSEMBLIES (type B).

Attenuating or divider PROBE ASSEMBLIES for direct connection to voltages exceeding 1 kV r.m.s. or d.c. but not exceeding 63 kV r.m.s. or d.c. The divider function may be carried out wholly within the PROBE ASSEMBLY, or partly in the test or measuring equipment intended to be used with the PROBE ASSEMBLY.

- c) Low-voltage attenuating or divider PROBE ASSEMBLIES (type C).

Attenuating, divider or other signal conditioning PROBE ASSEMBLIES for direct connection to voltages exceeding 30 V r.m.s or 42,4 V peak or 60 V d.c., but not exceeding 1 kV r.m.s, peak or d.c. The signal conditioning function may be carried out wholly within the PROBE ASSEMBLY, or partly within the test or measuring equipment intended to be used with the PROBE ASSEMBLY.

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## 2 Normative references

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This clause of part 1 is applicable.

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## 3 Definitions

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This clause of part 1 is applicable with the following additions:

*Additional definitions:*

### 3.101 PROBE ASSEMBLIES *and parts*

**3.101.1 PROBE ASSEMBLY:** A device for making temporary contact between measuring or test equipment and a point on an electrical circuit being measured or tested. It includes the cables and the means for making a connection with the measuring or test equipment.

**NOTE —** See figures 101 and 102 for examples of PROBE ASSEMBLIES and an explanation of the function of their parts.

**3.101.2 PROBE TIP:** The part of the PROBE ASSEMBLY which makes the connection to the point being measured or tested.

**3.101.3 REFERENCE CONNECTOR:** A device used to connect a reference point in the measuring or test equipment (usually the FUNCTIONAL EARTH TERMINAL) to a reference point on the electrical circuit being measured or tested.

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## 4 Tests

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This clause of part 1 is applicable with the following addition:

*Additional subclause:*

### 4.4.2.101 *Components*

Components (except HIGH INTEGRITY components) of type B and type C PROBE ASSEMBLIES shall be short-circuited or open-circuited, whichever is less favourable.

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## 5 Marking and documentation

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This clause of part 1 is applicable except as follows:

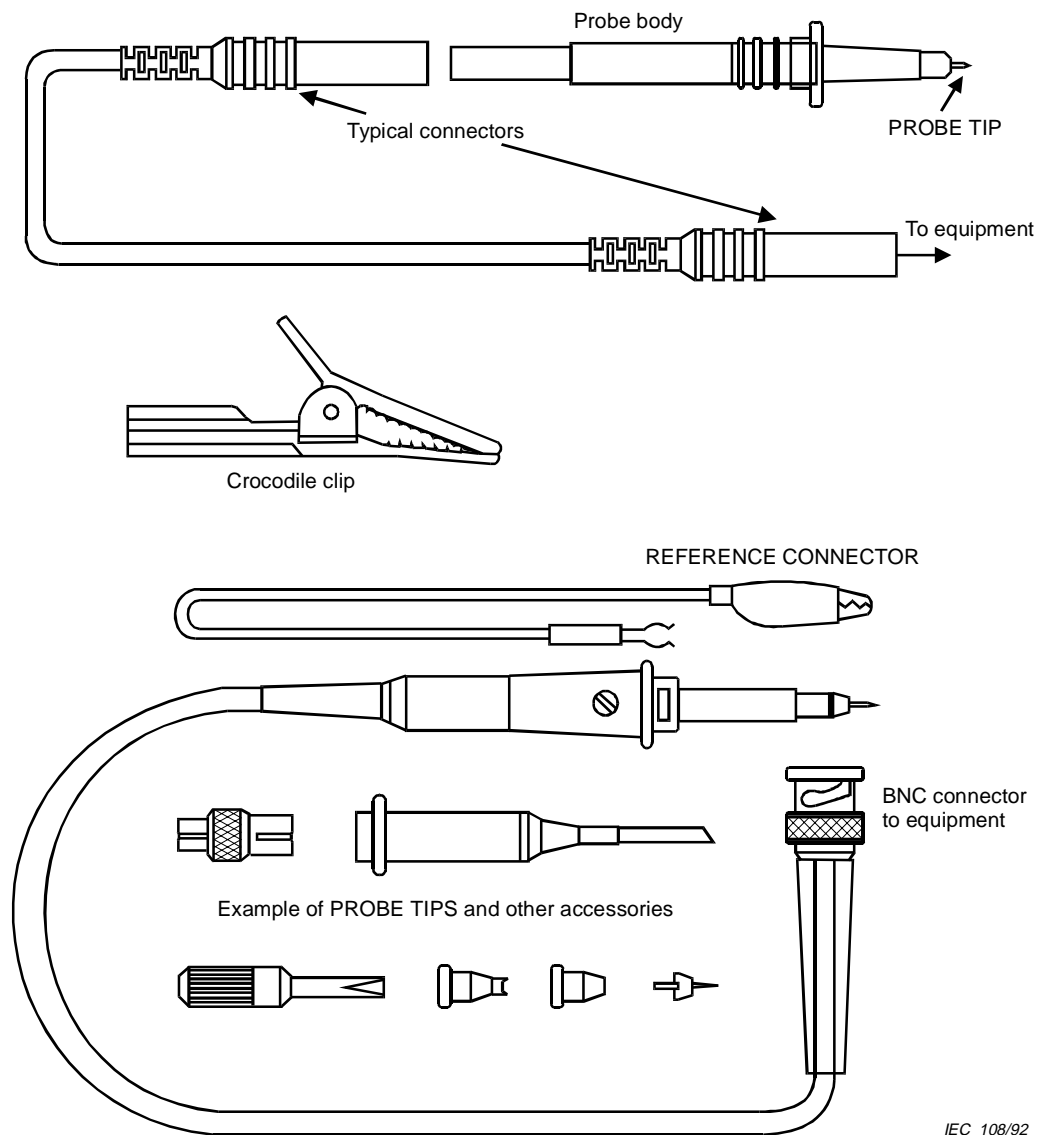
### 5.1.2 Identification

#### *Replacement:*

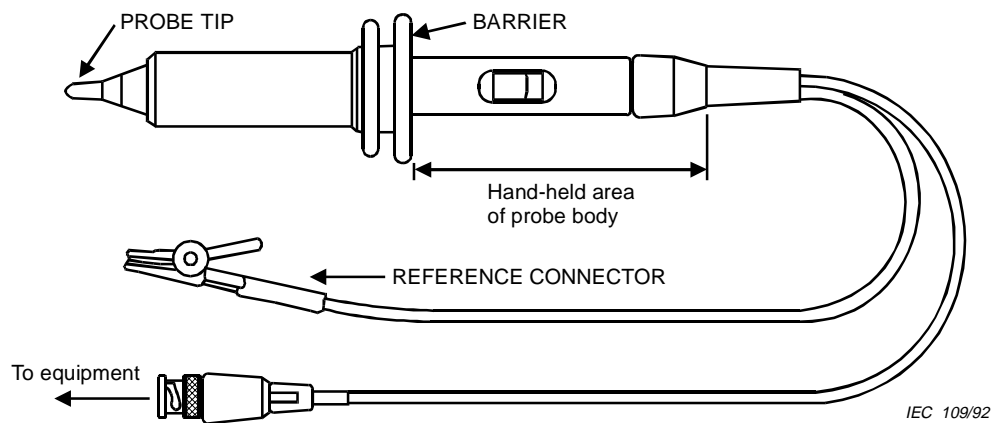
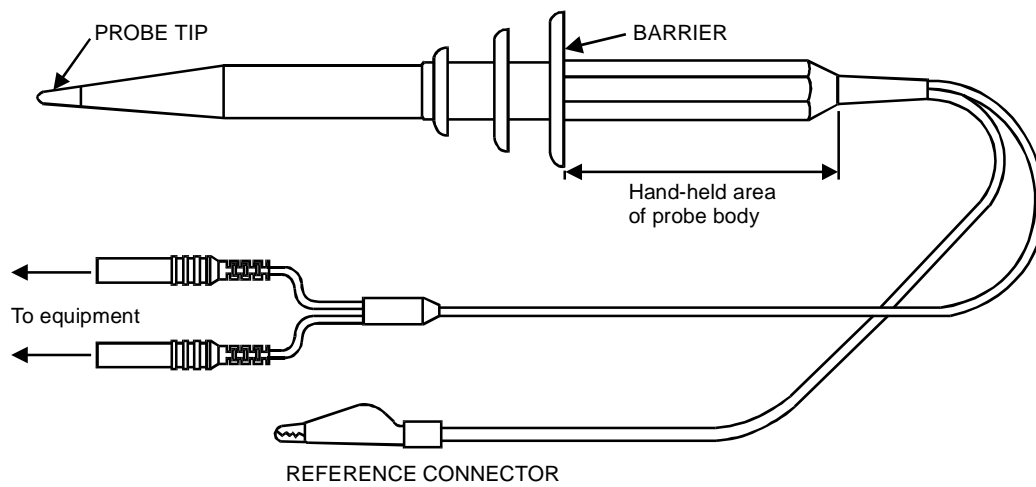
Each PROBE ASSEMBLY and separable mating part of a PROBE ASSEMBLY shall, as a minimum, be identified by marking showing:

- the name or registered trade mark of the manufacturer or supplier;
- in addition for types B and C only, the model number or name or other means of identifying the PROBE ASSEMBLY or part.

**NOTE —** It is not necessary to mark small general-purpose accessory parts such as alligator/crocodile clips, spade lugs, and screw-on or detachable PROBE TIPS.



**Figure 101 - Examples of type A and type C PROBE ASSEMBLIES**



IEC 109/92

**Figure 102 - Examples of type B PROBE ASSEMBLIES**

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.

*Compliance is checked by inspection.*

## **Table 1 — Symbols**

*Addition:*

*Under the text in column 2 for symbols 12 and 14 insert:*

*(see note)*

*At the bottom of the table insert:*

**NOTE** — Colour requirements for symbols 12 and 14 do not apply to markings on PROBE ASSEMBLIES, provided that the symbol is moulded or engraved to a depth or raised height of 0.5 mm.

### **5.1.4 Fuses**

*Replacement:*

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 fuses can safely interrupt at maximum RATED voltage). If the OPERATOR has to select a fuse according to the particular application, symbol 14 of table 1 shall be marked on the probe and the necessary information included in the documentation.

*Compliance is checked by inspection.*

### **5.1.5 Measuring circuit TERMINALS**

*This subclause is not applicable.*

*Additional subclause:*

#### **5.1.101 RATING**

The maximum RATED value of circuit-to-earth voltage shall be marked on the PROBE ASSEMBLY, preferably on the probe body ([see also 6.4.101](#)). The nature of the voltage (a.c, d.c., etc.) shall also be marked, unless the voltage marking applies to both a.c., r.m.s. and d.c.

If a REFERENCE CONNECTOR is intended for connection to points at a voltage level exceeding the values of 6.3.1.1, its voltage RATING shall be marked, preferably on the connector.

*Compliance is checked by inspection.*



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## 6 Protection against electric shock

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This clause of part 1 is applicable, except as follows:

### 6.1.1 *Exceptions*

*Add the following dash to the first paragraph:*

- PROBE TIPS, provided that they meet the requirements of 6.7.

Additional subclause:

### 6.2.101 PROBE ASSEMBLIES

Figure 103 gives methods for determination of ACCESSIBLE parts of PROBE ASSEMBLIES.

## 6.3 Permissible limits for ACCESSIBLE parts

*Addition:*

*Add the following new paragraph after the first paragraph:*

Measurements on PROBE ASSEMBLIES are carried out in accordance with figures 104 and 105.

### 6.3.1.2 *Current*

*Addition:*

*Add after the first dash:*

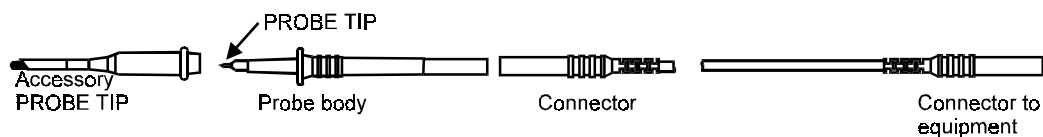
**NOTE** — Methods of measurement for frequencies above 1 MHz are under consideration.

### 6.3.2.2 *Current*

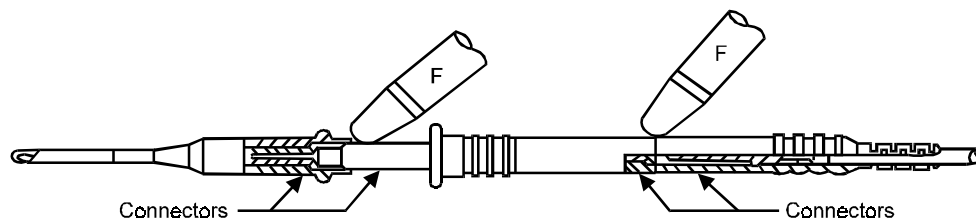
*Addition:*

*Add after the first dash:*

**NOTE** — Methods of measurement for frequencies above 1 MHz are under consideration.

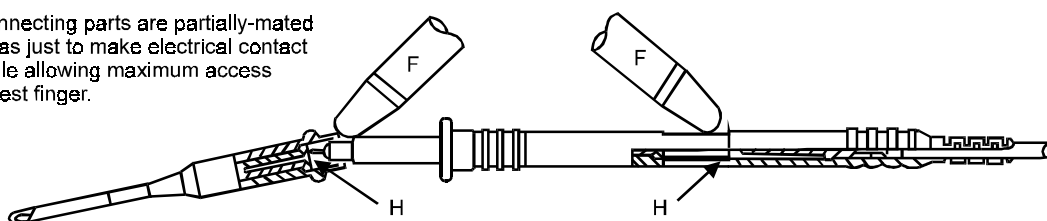


a) Parts of PROBE ASSEMBLY

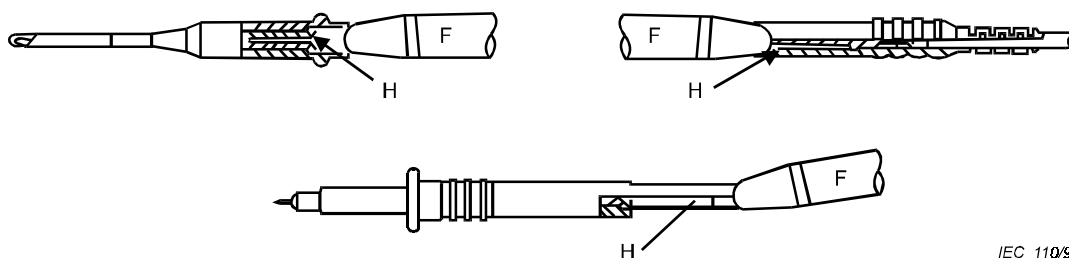


b) Fully-mated PROBE ASSEMBLY (see 6.2 and 6.4.102 a)

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



c) Partially-mated PROBE ASSEMBLY (see 6.2 and 6.4.102 b)

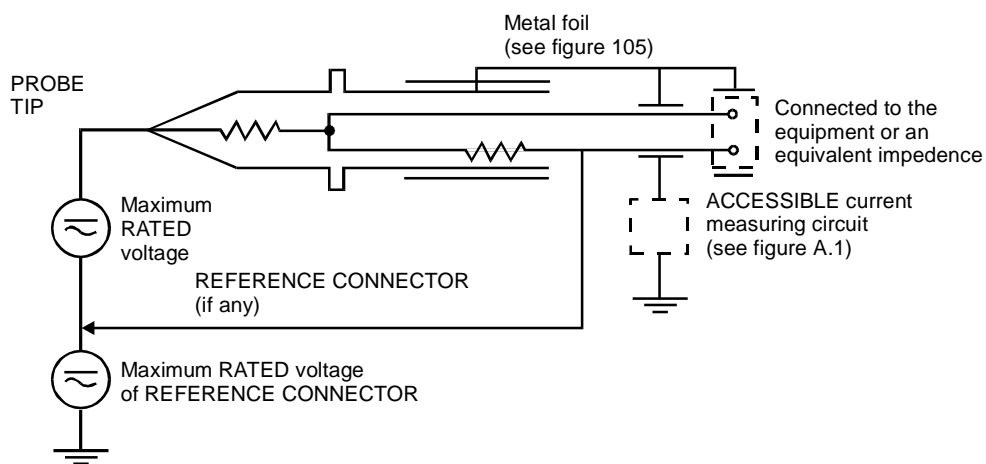


IEC 110/92

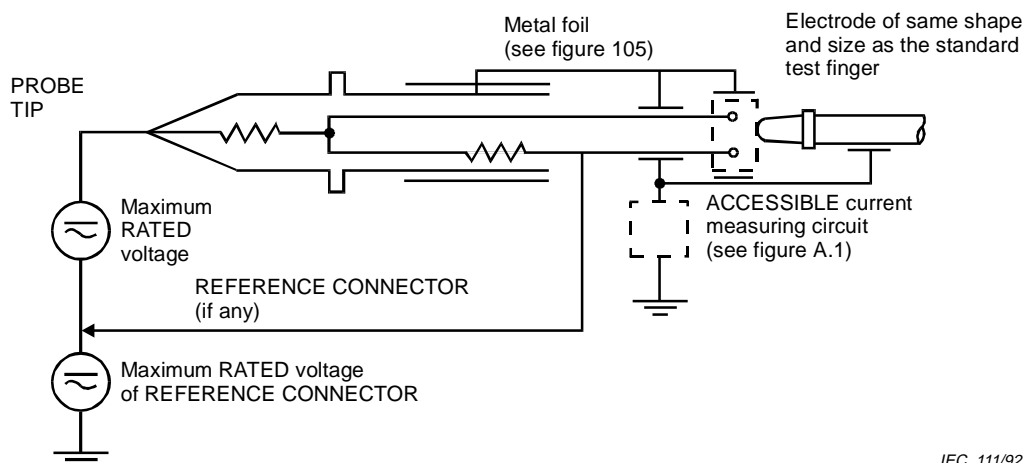
d) Unmated parts PROBE ASSEMBLY (see 6.2 and 6.4.102 c)

F = rigid test finger (see figure B.1)  
H = potentially HAZARDOUS LIVE part

**Figure 103 - Methods for determination of ACCESSIBLE parts (see 6.2) and for voltage tests (see 6.4.102)**



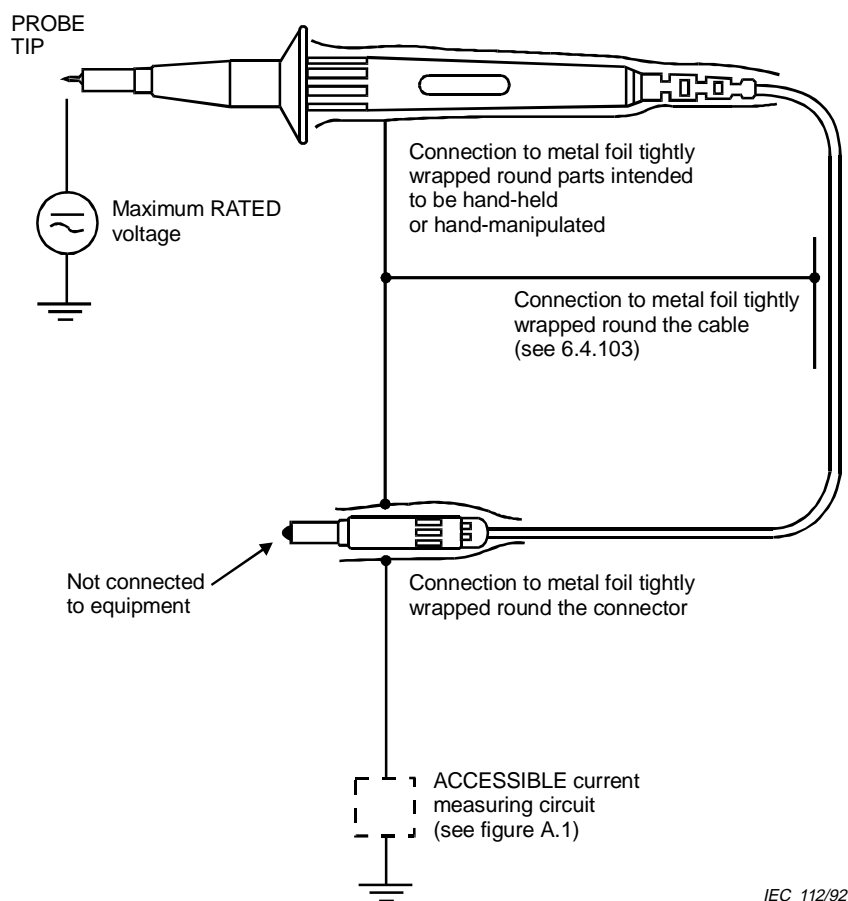
a) Measurement in NORMAL CONDITION (see 6.3.1.2)



IEC 111/92

b) Measurement in SINGLE FAULT CONDITION (see 6.3.2.2)

**Figure 104 - ACCESSIBLE current measurement (see 6.3)**



**Figure 105 - Application of metal foil for ACCESSIBLE current measurement (see figure 104)**

**NOTE** — The figure shows a type A PROBE ASSEMBLY during measurement in NORMAL CONDITION.

## 6.4 Protection in NORMAL CONDITION

*Additional subclauses:*

### 6.4.101 Separable parts

Except for REFERENCE CONNECTORS, the insulation of any part of a PROBE ASSEMBLY which is intended to be separated by an OPERATOR shall have insulation RATED for the same circuit-to-earth voltage as the RATED voltage of the PROBE ASSEMBLY or the parts shall be marked with its voltage RATING (see 5.1.101 and the note to 5.2).

*Compliance is checked by inspection.*

#### 6.4.102 Connectors

Insulation, ACCESSIBLE parts, CLEARANCES and CREEPAGE DISTANCES of connectors between parts of PROBE ASSEMBLIES shall meet the applicable requirements of a) to c) below.

- a) Fully mated connectors. The exterior of these connectors shall meet the following requirements, with CREEPAGE DISTANCES applicable to Material Group 1:
  - connectors used only for connecting the PROBE ASSEMBLY to the measuring or test equipment, and which are not intended to be hand-held after connection, shall be insulated from HAZARDOUS LIVE parts at least by BASIC INSULATION;
  - connectors which, when fully mated, are intended to be hand-held during measurement or test, and connectors which are interchangeable between the PROBE ASSEMBLY and the measuring or test equipment, shall be insulated from HAZARDOUS LIVE parts by DOUBLE INSULATION or REINFORCED INSULATION;
- b) Partially mated connectors. These shall pass the voltage test of 6.8 for BASIC INSULATION, between the PROBE TIP and a test electrode of the same shape and size as the end of the standard test finger of figure B1. This electrode is applied without force as near as possible to HAZARDOUS LIVE parts of the connector while it is mated just sufficiently to make electrical contact (see figure 103 c).
- c) Unmated connectors. Except for locking type connectors, parts which are HAZARDOUS LIVE when the maximum RATED voltage is applied to the PROBE ASSEMBLY shall meet the following requirements:
  - for connectors at voltages up to 1 kV a.c. or 1.5 kV d.c., HAZARDOUS LIVE parts of unmated connectors shall not be ACCESSIBLE with the standard test fingers of figures B.1 and B.2, applied without force.
  - for connectors at voltages above 1 kV a.c. or 1.5 kV d.c., the voltage test of 6.8 shall be applied between the HAZARDOUS LIVE parts and an electrode of the same shape and size as the end of the standard test figure B1, placed as near as possible to HAZARDOUS LIVE parts (see figure 103 d). The test voltage applied to the PROBE TIP shall be 1.25 times the RATED voltage of the PROBE ASSEMBLY.

This test is not required for connectors with ACCESSIBLE current limited by PROTECTIVE IMPEDANCE, provided that any resistors used in the PROTECTIVE IMPEDANCE meet the requirements of 14.6.101.

*Compliance is checked by inspection and measurement of CLEARANCES and CREEPAGE DISTANCES, by the voltage tests of 6.8, and by the determination of ACCESSIBLE parts according to 6.3.*

#### 6.4.103 Hand-held parts

Hand-held and hand-manipulated parts of PROBE ASSEMBLIES shall meet the requirements for DOUBLE INSULATION or REINFORCED INSULATION.

Compliance is checked by inspection and measurement of CLEARANCES and CREEPAGE DISTANCES, and by the voltage tests of 6.8 between metal foil tightly wrapped round parts intended to be hand-held or hand-manipulated and round a  $150\text{ mm} \pm 20\text{ mm}$  length of the cable, [see figure 105](#) and the following parts:

- the PROBE TIP. The test voltage is based on the RATED voltage of the PROBE ASSEMBLY;
- (type B only) the conductive parts enclosed by the hand-held area. The test voltage is based on the maximum working voltage of the conductive parts in NORMAL USE, but it is not less than 500 V;
- (type B only) the conductor of the REFERENCE CONNECTOR and the conductors of the connector for connecting the PROBE ASSEMBLY to the measuring or test equipment, joined together. The test voltage is based on the maximum RATED voltage of the PROBE ASSEMBLY divided by the divider ratio, but is not less than 500 V;
- (type C only) the conductor of the REFERENCE CONNECTOR if it is RATED above the voltage levels of 6.3.1.1. The test voltage is based on the maximum RATED voltage of the REFERENCE CONNECTOR.

**NOTE** — The voltage tests of insulation which covers parts which are not HAZARDOUS LIVE (e.g., the REFERENCE CONNECTOR) are to confirm the integrity of the insulation, not to impose additional requirements.

#### 6.4.104 Cables

Cables shall be RATED for the maximum voltage and current of NORMAL USE, and meet the requirements for DOUBLE INSULATION or REINFORCED INSULATION based on the following values:

- for type A PROBE ASSEMBLIES, 125 V or the maximum RATED voltage of the PROBE ASSEMBLY, whichever is greater;
- for type B PROBE ASSEMBLIES, 500 V or the maximum RATED voltage of the PROBE ASSEMBLY divided by the divider ratio, whichever is greater;
- for type C PROBE ASSEMBLIES, 125 V or the maximum RATED voltage of the PROBE ASSEMBLY divided by the divider ratio, whichever is greater.

Compliance is checked by inspection and measurement of CLEARANCES and CREEPAGE DISTANCES, and by the voltage tests of 6.8, using metal foil tightly wrapped round a  $150 \pm 20\text{ mm}$  length of cable.

### 6.7 CLEARANCES and CREEPAGE DISTANCES

*Additional subclauses:*

#### 6.7.101 PROBE TIP

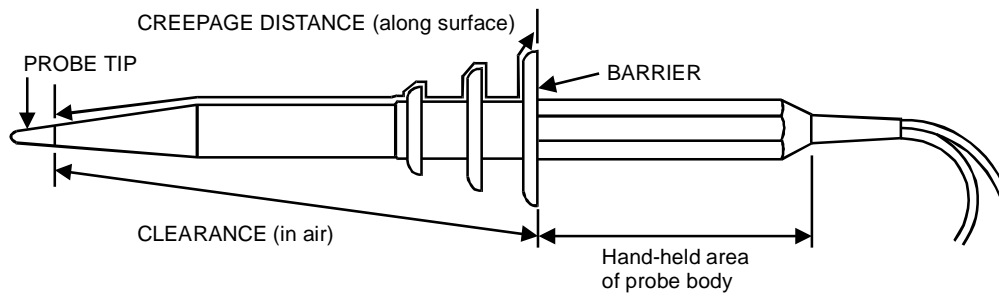
If as permitted by 6.1.1, a PROBE TIP can become HAZARDOUS LIVE, a BARRIER shall be fitted to provide a protective distance which reduces the danger of touching the PROBE TIP, and indicates the limit beyond which it may be hazardous to touch the probe body during use.

CLEARANCE and CREEPAGE DISTANCE between the PROBE TIP and the hand-held side of the BARRIER shall meet the requirements of annex D for DOUBLE INSULATION or REINFORCED INSULATION. Figure 106 a) gives examples of PROBE ASSEMBLIES with BARRIERS and indicates applicable CLEARANCES and CREEPAGE DISTANCES.

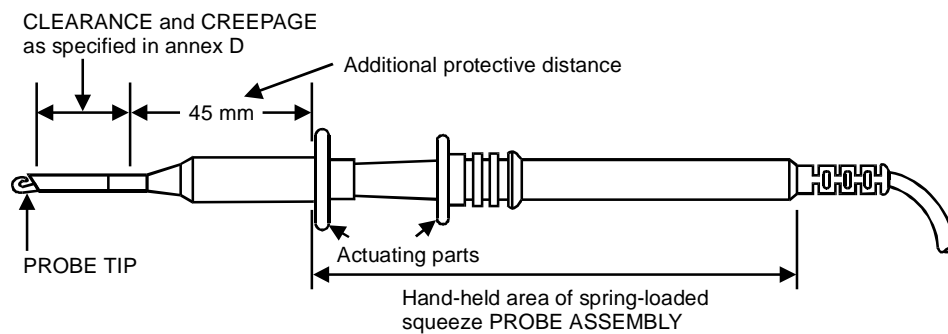
Spring-loaded squeeze probes (see figure 106 b) are acceptable without a BARRIER provided that:

- actuation of the spring-loaded mechanism prevents the OPERATOR touching a HAZARDOUS LIVE part;
- protection equivalent to protective distances is provided in all positions of NORMAL USE;
- CLEARANCE and CREEPAGE DISTANCE between the PROBE TIP and the nearest surface which the OPERATOR needs to touch to actuate the probe shall be 45 mm longer than that required for a BARRIER (figure 106 b) indicates this).

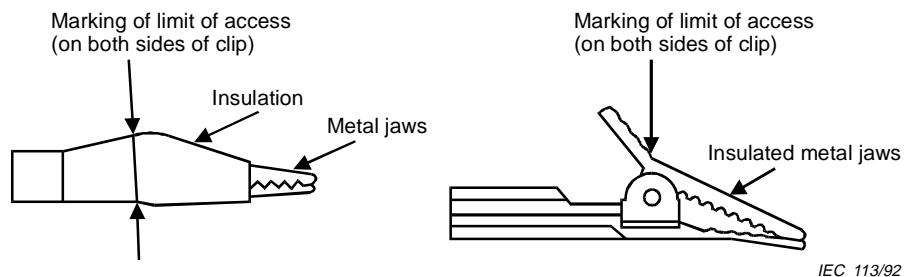
Insulated crocodile and similar clips (see figure 106 c) which require finger pressure at about 90° to the axis of the clip, are acceptable without a BARRIER provided that there is an indication of the limit of safe access for the OPERATOR. CLEARANCE and CREEPAGE DISTANCE between this indication and the tip of the clip shall meet the requirements of annex D for DOUBLE INSULATION.



a) Protection by BARRIER



b) Protection by distance



c) Insulated crocodile clips

**Figure 106 - Accessibility protection (see 6.7.101)**

The exposed conductive part of the PROBE TIP of a type A PROBE ASSEMBLY shall not be more than 19 mm long. A shorter length is recommended, or the use of a spring-loaded insulating sleeve.

*Compliance is checked by inspection and measurement.*



### **6.7.102 Type B PROBE ASSEMBLIES with maximum RATED voltage above 5 kV**

Where DOUBLE INSULATION or REINFORCED INSULATION is required for a PROBE ASSEMBLY with maximum RATED voltage above 5 kV, the CREEPAGE DISTANCE need not be larger than the value given in annex D for CLEARANCE, provided that the intended use is a type 1 or type 2 circuit according to table D.13.

## **6.9 Constructional requirements for protection against electric shock**

### **6.9.3 Equipment using PROTECTIVE BONDING**

This subclause is not applicable.

*Additional subclauses:*

#### **6.9.101 Corona and partial discharge**

The construction of a PROBE ASSEMBLY shall be such that, while operating at maximum RATED voltage, there is no corona or partial discharge.

*Compliance is under consideration.*

#### **6.9.102 Cable attachment**

The attachment of the cable to the probe body and to the equipment (or to the connectors if the attachment is not fixed) shall withstand forces likely to be encountered in NORMAL USE without damage which could cause a hazard. Soldered or welded electrical connections shall not be used for strain relief.

*Compliance is checked under inspection and by applying a pull test. With the probe body or equipment or connector clamped so that it cannot move, the cable is subjected for 1 min to a steady axial pull at the value shown below:*

- *for probe bodies and for locking connectors, 36 N or four times the mass of the probe body, whichever is less;*
- *for non-locking connectors, 36 N or four times the axial pull force required to disconnect the connector, whichever is less.*

*After the test:*

- *the cable shall not have been damaged;*
- *the insulation of the cable shall not have been cut or torn, and shall not have moved in the bushing;*
- *CLEARANCES and CREEPAGE DISTANCES shall not have been reduced below the applicable values of annex D.*

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## 7 Protection against mechanical hazards

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*Replacement:*

Handling of PROBE ASSEMBLIES during NORMAL USE shall not lead to a hazard.

**NOTE** — Easily touched edges, projections, etc. should be smooth and rounded so as not to cause injury during NORMAL USE (this does not apply to PROBE TIPS, plug pins, etc.)

*Compliance is checked by inspection.*

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## 8 Mechanical resistance to shock, vibration and impact

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This clause of part 1 is applicable except as follows:

### 8.1 Rigidity test

*Replacement:*

A force of 20 N is applied three times to each point on the PROBE ASSEMBLY which would be likely to cause a hazard if broken.

### 8.2 Impact hammer test

*Replacement:*

The probe body is held firmly against a rigid support and tested with the impact hammer specified in IEC 817 (see annex C). The hammer nose is pressed perpendicularly against the surface. Three blows, each with an energy of 0.5 J, are applied to each point which would be likely to cause a hazard if broken.

### 8.3 Vibration test

*This subclause is not applicable.*

### 8.4 Drop test

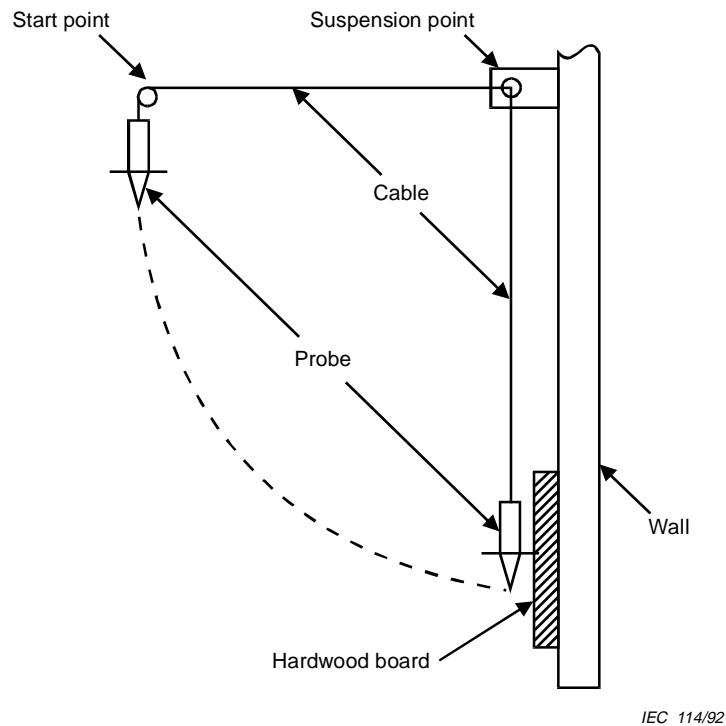
*Replacement:*

Three samples of the PROBE ASSEMBLY are each dropped three times through a distance of 1 m on to a hardwood board with a thickness of 50 mm and a density of more than 700 kg/m<sup>3</sup>, lying flat on a rigid base such as a concrete block. For each sample, the three tests are carried out so as to apply the impact to different points on the probe body.

*Additional subclause:*

### 8.101 *Impact swing test*

The probe body is subjected to impact against a hardwood board fixed to a solid wall, when swinging as a pendulum by its cable (see figure 107, below). The height of the drop shall be 2 m, or the probe cable length if shorter. The hardwood board shall have a thickness of 50 mm and a density of more than 700 kg/m<sup>3</sup>.



**Figure 107 - Impact swing test (see 8.101)**

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## 9 Equipment temperature limits and protection against the spread of fire

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This clause of part 1 is applicable except for subclauses 9.2.1 to 9.6 and with the following additions to table 3:

Hand-held and hand-manipulated parts of PROBE ASSEMBLIES, including parts of plugs or sockets used for connection to the measuring or test equipment:

metal:	55 °C
non-metallic (see note 5):	70 °C
wire and cable (see note 2):	75 °C

**NOTE 5** — The temperature of non-metallic parts is limited to the maximum RATED temperature of the material, if that is below 70 °C

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## 10 Resistance to heat

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This clause of part 1 is applicable except for the deletion of subclauses 10.2 and 10.3 and the addition of the following subclause:

*Additional subclause:*

### 10.101 *Resistance to heat of PROBE ASSEMBLIES*

PROBE ASSEMBLIES of non-metallic material shall be resistant to elevated temperatures.

*Compliance is checked by one of the following treatments:*

- *a non-operative treatment, in which the PROBE ASSEMBLY, not energized, is stored for 7 h at a temperature of 70 °C. However, if during the test of 10.1 a higher temperature is measured, the storage temperature is to be 10 °C above the measured temperature. If the PROBE ASSEMBLY contains components which might be damaged by this treatment, an empty PROBE ASSEMBLY may be treated, followed by assembly at the end of the treatment;*
- *an operative treatment, in which the PROBE ASSEMBLY is operated under the reference test conditions of 4.3 and in an ambient temperature of 60 °C.*

*After the treatment, the PROBE ASSEMBLY shall cause no hazard (see 1.2) and shall pass the tests of 6.8, 8.2, 8.4 and 8.101. CLEARANCE and CREEPAGE DISTANCES shall not have been reduced below the requirements of 6.7 and annex D.*

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## 11 Resistance to moisture and liquids

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This clause of part 1 is applicable except for subclauses 11.3 to 11.5.

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

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This clause of part 1 is not applicable.

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## 13 Protection against liberated gases, explosion and implosion

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*Replace this clause by the following:*

### **13.101 Arc explosion**

PROBE ASSEMBLIES shall incorporate protection against arc explosion if they are designed for making voltage measurements in circuits of INSTALLATION CATEGORY III (OVERVOLTAGE CATEGORY III), and are intended for use with a measuring instrument which does not itself have adequate protection against arc explosion.

*Compliance is checked by inspection and by testing with the PROBE ASSEMBLY connected across a circuit with the following characteristics:*

- *open-circuit voltage equal to the maximum RATED voltage of the PROBE ASSEMBLY;*
- *short-circuit current equal to the value of the maximum RATED voltage divided by the impedance of the PROBE ASSEMBLY.*

*During the test there shall be no explosion and after the test there shall be no visible damage to the insulation of the PROBE ASSEMBLY.*

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## 14 Components

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This clause of part 1 is applicable except for subclauses 14.2 and 14.5, and the addition of the following two subclauses:

*Additional subclauses:*

### 14.6.101 Resistors used in PROTECTIVE IMPEDANCE

Any resistor or resistor assembly forming part of a PROTECTIVE IMPEDANCE used in a PROBE ASSEMBLY (see 6.4.101) shall be a HIGH INTEGRITY resistor or assembly meeting the following requirements:

- a) the resistor or assembly shall withstand twice the dissipation occurring at the maximum RATED voltage of the PROBE;
- b) the resistor or assembly shall withstand twice the maximum RATED voltage of the PROBE for at least 1 s;
- c) the distance across the resistor or assembly shall be at least the value of CLEARANCE given in annex D for DOUBLE INSULATION at the maximum RATED voltage of the PROBE ASSEMBLY. If heating occurs at the maximum RATED voltage, then the applicable voltage for the CLEARANCE shall be multiplied by  $T_2/T_1$ , where  $T_1$  is the ambient temperature and  $T_2$  the internal temperature of the PROBE ASSEMBLY around the resistor (both in kelvins).

*Compliance is checked by the measurements and tests specified above.*

### 14.101 Fuses

If a fuse is installed in a PROBE ASSEMBLY, it shall have a voltage RATING at least as high as the maximum RATED voltage of the PROBE ASSEMBLY, and an appropriate breaking capacity and current RATING for the intended application of the PROBE ASSEMBLY (see also 5.1.4).

**NOTE** — The minimum breaking capacity will normally need to be the current produced by dividing the maximum RATED voltage by the impedance of the PROBE ASSEMBLY or pair of PROBE ASSEMBLIES as appropriate.

*Compliance is checked by inspection.*

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## 15 Protection by interlocks

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This clause of part 1 is not applicable.

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## Annexes

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The annexes of part 1 are applicable with the following additions:

### Annex M

*Additional defined terms:*

PROBE ASSEMBLY	3.101.1
PROBE TIP	3.101.2
REFERENCE CONNECTOR	3.101.3







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