

# NATIONAL STANDARD OF CANADA NORME NATIONALE DU CANADA

# CAN/ULC-61243-3-15 (IEC 61243-3:2014 MOD)

La norme internationale IEC 61243-3:2014, (troisième édition, 2014-10), inclusive de corrigenda 1 (janvier 2015) et 2 (mai 2015), a été adoptée avec les exigences propres au Canada (MOD), et porte la désignation **CAN/ULC-61243-3-15** la troisième édition. Elle a été approuvée comme Norme nationale du Canada par le Conseil canadien des normes.

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International Standard IEC 61243-3:2014 (Third Edition, 2014-10), inclusive of Corrigenda 1 (January, 2015) and 2 (May, 2015) has been adopted with Canadian deviations (MOD) as the Third Edition of **CAN/ULC-61243-3-15**, which has been approved as a National Standard of Canada by the Standards Council of Canada.

ISSN 0317-526X

June 2015

## Travaux sous tension – DéTECTEURS de tension – Partie 3: Type bipolaire basse tension

ICS 13.260, 29.240.20, 29.260.99

## Live working - Voltage detectors - Part 3: Two- pole low-voltage type

ICS 13.260, 29.240.20, 29.260.99



Numéro de référence  
Reference Number  
IEC 61243-3:2014

**Commission Electrotechnique Internationale  
International Electrotechnical Commission**

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Il est recommandé aux personnes qui ont besoin d'utiliser des normes de se servir des NNC. Ces normes font l'objet d'examen périodiques; c'est pourquoi l'on recommande aux utilisateurs de se procurer l'édition la plus récente de la norme auprès de l'OEN qui l'a publiée.

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Le but premier visé par cette norme est énoncé au paragraphe qui en définit le domaine d'application. Il importe de préciser qu'il incombe à l'utilisateur de décider si la norme convient à ses besoins particuliers.

The intended primary application of this Standard is stated in its scope. It is important to note that it remains the responsibility of the user of the Standard to judge its suitability for this particular application.

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An important facet of the Canadian standards development system is the use of the following principles: consensus; equal access and effective participation by concerned interests; respect for diverse interests and identification of those who should be afforded access to provide the needed balance of interests; mechanism for dispute resolution; openness and transparency; open access by interested parties to the procedures guiding the standards development process; clarity with respect to the processes; and Canadian interest consideration as the initial basis for the development of standards.

A National Standard of Canada (NSC) is a standard prepared or reviewed by an SCC-accredited SDO and approved by the SCC according to NSC approval requirements. Approval does not refer to the technical content of the standard, as this remains the responsibility of the SDO. An NSC reflects a consensus of a number of capable individuals whose collective interests provide, to the greatest practicable extent, a balance of representation of general interests, producers, regulators, users (including consumers) and others with relevant interests, as may be appropriate to the subject at hand. NSCs are intended to make a significant and timely contribution to the Canadian interest.

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**NORME NATIONALE DU CANADA**

**NATIONAL STANDARD OF CANADA**

CAN/ULC-61243-3-15  
(IEC 61243-3:2014, MOD)

**Travaux sous tension – Détecteurs de  
tension – Partie 3: Type bipolaire  
basse tension**

ICS 13.260, 29.240.20, 29.260.99

CAN/ULC-61243-3-15  
(IEC 61243-3:2014, MOD)

**Live working - Voltage detectors - Part  
3: Two-pole low-voltage type**

ICS 13.260, 29.240.20, 29.260.99

Préparée par / Prepared by  
**International Electrotechnical Commission**  
**Commission Électrotechnique Internationale**



Examinée par / Reviewed by



Approuvée par le / Approved by



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11/11/2015 11:11:11 AM

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| G. Ottley                    | ULC Standards/ Normes ULC                                                          | Canada                                    | (Project Manager<br>Non-voting) /<br>(Gestionnaire de projet<br>sans droit de vote) |

Il s'agit de la liste des membres du comité au moment de l'approbation de présent document.  
La composition du comité peut avoir changé depuis ce temps-là.

This list represents the membership at the time the Committee balloted on the final text of this edition. Since that time, changes in the membership may have occurred.

# CAN/ULC-61243-3-15 (IEC 61243-3:2014, MOD)

## Travaux sous tension – Détecteurs de tension – Partie 3: Type bipolaire basse tension

### PRÉFACE NORMES ULC

Ce document constitue la troisième édition de la norme, CAN/ULC-61243-3-15 (IEC 61243-3:2014, MOD), Travaux sous tension – Détecteurs de tension – Partie 3: Type bipolaire basse tension, laquelle constitue une adoption, avec les exigences propres au Canada, de la norme internationale de la Commission Électrotechnique Internationale, IEC 61243-3 (troisième édition, 2014-10).

Au Canada, il y a deux langues officielles, le français et l'anglais. Tous les avertissements de sécurité doivent être en français et en anglais. Il importe de signaler que certaines autorités canadiennes peuvent exiger que des marquages et/ou des directives d'installation supplémentaires soient dans les deux langues officielles.

Cette troisième édition de la norme nationale du Canada remplace désormais la deuxième édition.

Il est possible que certains éléments de la présente norme canadienne soient sujets à des droits en matière de brevet. Normes ULC n'est pas tenu de signaler dans quelles circonstances ces droits en matière de brevet peuvent s'appliquer.

La révision de cette norme débutera dans les 5 ans suivant la date de publication, à moins que la norme soit désignée comme entrant dans une catégorie stabilisée, auquel cas la révision commencera dans le délai approprié défini par Normes ULC.

La présente norme est destinée à être utilisée à des fins d'évaluation de la conformité.

Une grande partie du financement nécessaire au processus d'adoption de cette Norme nationale du Canada a été assurée par l'association canadienne de l'électricité (ACE) que nous tenons à remercier.

Juin 2015

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# **CAN/ULC-61243-3-15**

## **(IEC 61243-3:2014, MOD)**

### **Live working - Voltage detectors - Part 3: Two-pole low-voltage type**

## **ULC STANDARDS PREFACE**

This is the Third Edition of the Standard CAN/ULC-61243-3-15 (IEC 61243-3:2014, MOD), Live working - Voltage detectors - Part 3: Two-pole low-voltage type, with Canadian Deviations, of the international standard by International Electrotechnical Commission, IEC 61243-3:2014 (Third Edition, 2014-10).

In Canada there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

The requirements of Third Edition of this National Standard now supersede the Second Edition.

Attention is drawn to the possibility that some of the elements of this Canadian standard may be the subject of patent rights. ULC Standards shall not be held responsible for identifying any or all such patent rights.

The initiation of the review of this Standard will commence within 5 years of the date of publication, unless the Standard is identified as fitting within a stabilized category, whereby the review will commence within the appropriate time frame set out by ULC Standards

This Standard is intended to be used for conformity assessment.

Major funding in support of the adoption process of this National Standard of Canada was provided by the Canadian Electricity Association (CEA), whose assistance is acknowledged with thanks.

June 2015

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# Exigences propres au Canada

## GÉNÉRALITÉS

[Remplacez tous les références « IEC 61318 » dans le document avec « CAN/ULC-61318 »]

[Remplacez tous les références « IEC 61477 » dans le document avec « CAN/ULC-61477 »]

## 2 RÉFÉRENCES NORMATIVES

[Reviser les références IEC 61318 et IEC 61477 comme suit:

« CAN/ULC-61318-08, Travaux sous tension – Évaluation de la conformité applicable à l'outillage, au matériel et aux dispositifs (CEI/IEC 61318:2007, IDT)»

« CAN/ULC-61477-11, Travaux sous tension – Exigences minimales pour l'utilisation des outils, dispositifs et équipements (CEI/IEC 61477:2009, MOD)»]

## 4.5 MARQUAGE

### 4.5.2 Marquage sur l'indicateur

[Réviser la deuxième point avec tiret comme suit :

« –numéro de la norme CAN/ULC applicable (CAN/ULC-61243-3). »]

[Réviser la dernier paragraphe avec tiret comme suit :

«Le fabricant doit fournir les informations relatives au numéro de la norme CAN/ULC avec l'année de publication avec chaque *détecteur de tension* ou chaque lot de détecteurs de tension. »]

## ANNEXE B

[Supprimer l'annexe B.]

# Canadian Deviations

## GENERAL

[Change all "IEC 61318" references in the document to read "CAN/ULC-61318"]

[Change all "IEC 61477" references in the document to read "CAN/ULC-61477"]

## 2 NORMATIVE REFERENCES

[Revise IEC 61318 and IEC 61477 to read:

"CAN/ULC-61318-08, Live Working – Conformity assessment applicable to tools, devices and equipment (CEI/IEC 61318:2007, IDT)"

"CAN/ULC-61477-11, Live Working – Minimum requirements for the utilizations of tools, devices and equipment (CEI/IEC 61477:2009, MOD)"

## 4.5 MARKING

### 4.5.2 Marking on the indicator

[Revise the second dash item to state:

"– number of the relevant CAN/ULC standard (CAN/ULC-61243-3)."]

[Amend the final paragraph to reference CAN/ULC Standard:

"With every voltage detector or with every batch of voltage detectors to be delivered, the manufacturer shall provide information related to the number of the CAN/ULC standard."]

## ANNEX B

[Delete Annex B]



# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

**Live working – Voltage detectors –  
Part 3: Two-pole low-voltage type**

**Travaux sous tension – Détecteurs de tension –  
Partie 3: Type bipolaire basse tension**



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IEC 61243-3

Edition 3.0 2014-10

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Live working – Voltage detectors –  
Part 3: Two-pole low-voltage type**

**Travaux sous tension – Détecteurs de tension –  
Partie 3: Type bipolaire basse tension**

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ELECTROTECHNICAL  
COMMISSION

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ELECTROTECHNIQUE  
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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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**LIVE WORKING –  
VOLTAGE DETECTORS –****Part 3: Two-pole low-voltage type****FOREWORD**

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International Standard IEC 61243-3 has been prepared by IEC technical committee 78: Live working.

This third edition cancels and replaces the second edition published in 2009. It is a technical revision.

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

- requirement and test to manage *interference voltages* at power frequencies;
- informative annex on *voltage detectors* and the presence of *interference voltages*.

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

|              |                  |
|--------------|------------------|
| FDIS         | Report on voting |
| 78/1054/FDIS | 78/1090/RVD      |

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

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

Terms defined in Clause 3 are given in italic print throughout this standard.

A list of all parts of the IEC 61243 series can be found, under the general title *Live working – Voltage detectors*, on the IEC website.

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

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

The contents of the corrigendum of January 2015 have been included in this copy.

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

## INTRODUCTION

The devices covered by this standard are designed to be used in a live working environment to determine the status (presence or absence of operating voltage) of low-voltage installations.

The live working environment comes with its specific hazards and working conditions, which are generally more severe than the ones encountered by workers in other fields than live working.

This International Standard is a product standard giving essential requirements and tests to verify that the devices perform well and will contribute to the safety of the users, provided they are used by skilled persons, and according to safe working procedures and to local or national regulations.

Voltage detectors are not considered as measuring or testing devices, separately covered by IEC 61010 series. However, in case of misuse by general electrical workers, the requirements and tests included in this document are intended to achieve an equivalent level of safety.

To take into consideration the specific needs of a live working environment, the following differences exist with IEC 61010 series:

- some requirements and tests exist in both standards but with different sanctions or pass test criteria (see A.1);
- some requirements of IEC 61010 are not included in this standard (see A.2, with rationale);
- some additional requirements of this standard are not specified in IEC 61010 with the rationale (see A.3).

This International Standard has been prepared according to the requirements of IEC 61477, where applicable.

The product covered by this standard may have an impact on the environment during some or all stages of its life cycle. These impacts can range from slight to significant, be of short-term or long-term effect, and occur at the global, regional or local level.

This standard does not include requirements and test provisions for the manufacturers of the product, or recommendations to the users of the product for environmental improvement. However, all parties intervening in its design, manufacture, packaging, distribution, use, maintenance, repair, reuse, recovery and disposal are invited to take account of environmental considerations.

## LIVE WORKING – VOLTAGE DETECTORS –

### Part 3: Two-pole low-voltage type

#### 1 Scope

This part of IEC 61243 is applicable to hand-held *two-pole voltage detectors* with their accessories (crocodile clips and detachable *leads*) to be used in contact with parts of electrical systems:

- for a.c. voltages not exceeding 1 000 V at nominal frequencies between 16 2/3 Hz and up to 500 Hz,

and/or

- for d.c. voltages not exceeding 1 500 V.

NOTE The a.c. voltages defined in this standard refer either to phase-to-phase voltages or phase to neutral voltages.

*Contact electrode* extensions are not covered by this standard.

*Voltage detectors* covered by this standard are intended to be used under dry and humid conditions, both indoor and outdoor. They are not intended to be used under rain conditions.

*Voltage detectors* covered by this standard are not intended to be used for continuous operation.

*Voltage detectors* covered by this standard are intended to be used up to 2 000 m above sea level.

This standard also includes provisions for the following supplementary functions when available (see Annex B):

- phase indication,
- rotating field indication, and
- continuity check.

Other supplementary functions are not covered by this standard.

*Voltage detectors* covered by this standard are not considered as measuring devices. Relevant safety requirements for measuring devices are included in IEC 61010 series.

#### 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-31, *Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens*

IEC 60068-2-75:1997, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60304, *Standard colours for insulation for low-frequency cables and wires*

IEC 60417, *Graphical symbols for use on equipment*. Available from: <http://www.graphical-symbols.info/equipment>

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

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60529:1989/AMD1:1999

IEC 60529:1989/AMD2:2013<sup>1</sup>

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60664-3, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution*

IEC 60695-10-2:2003, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test method*

IEC 60942, *Electroacoustics – Sound calibrators*

IEC 61010-031:2002, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 031: Safety requirements for hand-held probe assemblies for electrical measurement and test*

IEC 61010-031:2002/AMD1:2008<sup>2</sup>

IEC 61010-1:2001<sup>3</sup>, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*

IEC 61140:2001, *Protection against electric shock – Common aspects for installation and equipment*

Amendment 1:2004

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

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

IEC 61260, *Electroacoustics – Octave-band and fractional-octave-band filters*

<sup>1</sup> There exists a consolidated edition 2.2 (2013) that includes IEC 60529:1989 and its Amendments 1 and 2.

<sup>2</sup> There exists a consolidated edition 1.1 (2008) that includes IEC 61010-031:2002 and its Amendment 1.

<sup>3</sup> Second edition, replaced by a third edition in 2010.

IEC 61318, *Live working – Conformity assessment applicable to tools, devices and equipment*

IEC 61326-1:2005, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

IEC 61477, *Live working – Minimum requirements for the utilization of tools, devices and equipment*

IEC 61557-7:2007, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 7: Phase sequence*

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

ISO 286-1, *Geometrical product specifications (GPS) – ISO code system for tolerances on linear sizes – Part 1: Bases of tolerances, deviations and fits*

ISO 286-2, *Geometrical product specifications (GPS) – ISO code system for tolerances on linear sizes – Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

ISO 354, *Acoustics – Measurement of sound absorption in a reverberation room*

ISO 3744:1994<sup>4</sup>, *Acoustics – Determination of sound power levels of noise sources using sound pressure – Engineering method in an essentially free field over a reflecting plane*

ISO 3745, *Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Precision methods for anechoic rooms and hemi-anechoic rooms*

ISO 7000, *Graphical symbols for use on equipment – Registered symbols. Available at: <http://www.graphical-symbols.info/equipment>*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61318 and the following apply.

#### 3.1

##### **basic insulation**

insulation applied to live parts of a *voltage detector* to provide basic protection against electric shock

Note 1 to entry: *Basic insulation* does not necessarily include insulation used exclusively for functional purposes (see 3.10.1 of IEC 61140:2001).

[SOURCE: IEC 60664-1:2007, 3.17.2 modified – The definition has been modified to fit the specific context of a *voltage detector*.]

#### 3.2

##### **clear indication**

unambiguous detection and indication of the voltage state between the *contact electrodes*

<sup>4</sup> Second edition, replaced by a third edition in 2010.

### 3.3

#### **clear perceptibility**

case where the indication is unmistakably discernible by the user under specific environmental conditions when the *voltage detector* is in its operating position

### 3.4

#### **contact electrode**

conductive part of the *probe* which establishes the electric connection to the part to be checked

Note 1 to entry: In certain designs, a part of the *contact electrode* is covered with insulating material.

### 3.5

#### **extra low voltage**

#### **ELV**

voltage below 50 V a.c. or 120 V d.c.

### 3.6

#### **hand-guard**

distinctive physical barrier (fixed to or part of the *probe*) to prevent the fingers or hands of the operator from inadvertently touching the *contact electrode* or any energized part

### 3.7

#### **hazardous live**

capable of rendering an electrical shock or electrical burn in *normal condition* or *single fault condition*

### 3.8

#### **indicating voltage**

#### $U_i$

approximate value of the operating voltage identified by the *voltage detector*

Note 1 to entry: The *indicating voltage* of the *voltage detector* is the parameter associated with its *clear indication*. Certain types of *voltage detectors* may have several *indicating voltages* and/or several *indicating voltage ranges*. Limit values of a voltage range are named  $U_i$  min. and  $U_i$  max.

### 3.9

#### **indicator**

part of the *voltage detector* which indicates the presence of the operating voltage between the *contact electrodes*

Note 1 to entry: The *indicator* may provide as well information related to supplementary functions.

### 3.10

#### **inspection**

conformity evaluation by observation and judgement, accompanied as appropriate by measurement, testing, gauging or calculation

SOURCE: ISO 9000:2005, 3.8.2 modified – The definition has been modified to include calculation.]

### 3.11

#### **interference voltage**

voltage at power frequency picked up inductively or capacitively by the part to be tested

### 3.12

#### **internal energy source**

integrated functional power supply

**3.13****lead**

flexible cable connecting different components of the *voltage detector* together

**3.14****normal condition**

condition in which all means of protection are intact

[SOURCE: IEC Guide 104:2010, 3.7]

**3.15****probe**

insulated part of a *voltage detector* intended to be handled by the user to bring its *contact electrode* in contact with the component to be checked

Note 1 to entry: The *probe* may contain the *indicator*.

Note 2 to entry: The *probe* does not include a *lead*. The *probe* and the *lead* may be detachable or not.

**3.16****protective impedance**

component, assembly of components or the combination of *basic insulation* and a current or voltage-limiting device, whose impedance, construction and reliability are such that, when connected between accessible conductive parts which are hazardous when live, it provides protection to the extent required by this standard in *normal condition* and *single fault condition*

**3.17****reasonably foreseeable misuse**

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

[SOURCE: ISO/IEC Guide 51:2014, 3.14, modified – The two notes to entry in the original have been deleted.]

**3.18****recovery time**

$r_t$

minimum no-load time between two uses as specified by the manufacturer

**3.19****response time**

time delay between a sudden change of the voltage state between the *contact electrodes* and the associated *clear indication*

**3.20****single fault condition**

condition in which one means of protection against hazards 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 are considered as one *single fault condition*.

[SOURCE: IEC Guide 104:2010, 3.8, modified – The wording has been changed to refer specifically to the potential hazards involved.]

**3.21****temporary overvoltage**

power frequency overvoltage of relatively long duration

Note 1 to entry: This overvoltage is undamped or weakly damped. In some cases its frequency may be several times smaller or higher than power frequency.

[SOURCE: IEC 60050-604:1987/AMD1:1998, 604-03-12]

### 3.22

#### **testing element**

built-in element or separate device, by means of which the functioning of the *voltage detector* can be checked by the user

### 3.23

#### **threshold voltage**

$U_t$

minimum voltage between the two *contact electrodes* required to give a *clear indication*

### 3.24

#### **time rating**

$t_r$

specified on-load time during which the *voltage detector* is able to operate correctly

### 3.25

#### **transient overvoltage**

a short duration overvoltage of few milliseconds or less, oscillatory or non-oscillatory, usually highly damped

[SOURCE: IEC 60050-604:1987/AMD1:1998, 604-03-13, modified – The two notes to entry in the original have been deleted.]

### 3.26

#### **two-pole voltage detector**

*voltage detector* for bi-polar application, made of two *probes*, an *indicator* included or not in one of the *probes* and *lead(s)*

Note 1 to entry: The term *voltage detector* is used in this document for two-pole low *voltage detector*.

### 3.27

#### **voltage detector**

device used to provide clear evidence of the presence or absence of the operating voltage

[SOURCE: IEC 60743:2013, 11.3.6, modified – The definition has been modified to fit the specific context. Notes 1 and 2 to entry have been deleted.]

### 3.28

#### **secondary network**

network which has no direct connection to primary power

## **4 Requirements**

### **4.1 General requirements**

#### **4.1.1 Safety**

*Voltage detectors* covered by this standard shall be designed and manufactured in order to contribute to the safety of the users, provided the *voltage detectors* are used by skilled persons, in accordance with safe methods of work and the instructions for use.

#### 4.1.2 Indication

The *voltage detector* shall give a *clear indication* of the state "voltage present" of the operating voltage by means of the status change of the signal. The indication shall be visual. An audible indication is optional. Simultaneous indications shall be provided when the *voltage detector* has more than one system of indication.

The visual indication (display) can be of different types but the *clear indication* of the presence of the operating voltage shall not display a discrete voltage value.

NOTE 1 Displays could consist of: change of the lighting state of light-emitting diodes (LEDs), movement of a needle or of other current activated component, alphanumeric characters on a screen, etc.

Displays providing a discrete voltage value are considered as supplementary measuring functions and should fulfil the relevant standards.

#### 4.1.3 Electromagnetic compatibility (EMC)

*Voltage detectors* shall comply with the requirements of class A equipment for use in industrial locations according to IEC 61326-1.

NOTE In some countries additional requirements may be needed to fulfil EMC regulations.

### 4.2 Functional requirements

#### 4.2.1 Clear indication

##### 4.2.1.1 Clear indication of the operating voltage and threshold voltage

The *voltage detector* shall clearly indicate at its nominal frequency or nominal frequencies the presence of

- every *indicating voltage* and/or,
- every *indicating voltage range*.

For *voltage detectors* having successive indications or successive range of indication (step by step), the change of state:

- of each step of the *indicating voltage* ( $U_i$ ) shall be limited to the interval included between  $1,1 U_{i(\text{step}-1)}$  and  $0,85 U_{i(\text{step})}$ ;
- of each step of *indicating voltage range* ( $U_i \text{ min, } U_i \text{ max}$ ) shall be limited to the interval included between  $1,1 U_{i(\text{step}-1) \text{ max}}$  and  $0,85 U_{i(\text{step}) \text{ min}}$ .

For *voltage detectors* having single indication, the change of state of the *indicating voltage* shall occur below  $0,85 U_i$ .

The user shall not have access to the *threshold voltage* setting.

The user shall not have access to any switches used for scale change.

##### 4.2.1.2 Clear indication of a voltage above the ELV

The *voltage detector* shall clearly indicate the presence of a voltage above the ELV limit by having a ELV limit indication.

The ELV limit indication shall function properly at all nominal frequencies when the voltage on the part to be checked is equal to or higher than the ELV limit (50 V a.c. and/or 120 V d.c).

NOTE 1 The ELV limit indication is only to warn the user of the presence of a voltage, not for its evaluation.

*Voltage detectors* with *internal energy source* shall still provide the ELV limit indication when the *internal energy source* is exhausted.

NOTE 2 For a *voltage detector* without an *internal energy source*, the possibility of the ELV limit indication is always maintained by the main circuit.

In the presence of a voltage above the ELV limit, the ELV limit indicating circuit shall remain operational at all times. For *voltage detectors* having overcurrent protective devices or switches for temporary loading or other voltage actuation methods, the ELV limit indication shall be present at all times when the voltage on the part to be checked is in excess of the ELV limit.

#### 4.2.1.3 Continuous indication

The *voltage detector* shall give continuous indication only in case of positive contact of the *contact electrodes* with bare live part(s) of the installation.

#### 4.2.1.4 Successive indication

*Voltage detectors* indicating more than one operating voltage shall be so designed and constructed that when the presence of an operating voltage is indicated, all *indicators* for operating voltages below this level shall also indicate a presence of voltage. The *voltage detector* shall indicate an increasing voltage in the sequence from the lower to the higher level indication and by decreasing in the inverse manner.

#### 4.2.1.5 Management of interference voltages at power frequencies (50 Hz/60 Hz)

The purpose of *voltage detectors* covered by this standard is to provide clear evidence of the presence or absence of the operating voltage. In case of *interference voltages* on the part to be tested, the indication may be different according to the internal impedance of *voltage detectors*.

*Voltage detectors* shall be evaluated in terms of their internal impedance for the a.c. power frequency value of the ELV.

Moreover a *voltage detector* claiming to be able to distinguish an operating voltage from an *interference voltage* shall indicate which type of voltage is present. This indication shall fulfil the *clear perceptibility* requirements. The *voltage detector* shall also pass the test for the influence of *interference voltage* (see 5.3.1.4.3).

According to the internal impedance of the *voltage detector*, safety advices shall be included in the instructions for use (see Annex C).

### 4.2.2 Clear perceptibility

#### 4.2.2.1 Visual indication

The indication shall be clearly visible to the user in the operating position and under normal light conditions.

When more than one visual indication is provided by a same light source, the change of indication shall not rely only on the change of colour of this light source. Additional characteristics, such as distinctive forms of the light signals, or flashing lights shall be used.

In case of physically separated light sources, when each provides a single visual indication, only one light colour may be used, no additional characteristics are needed.

NOTE In case of successive indication, all light sources are considered as parts of a same visual indication.

#### 4.2.2.2 Audible indication (when available)

The indication shall be clearly audible to the user in the operating position and under normal noise conditions.

When more than one audible signal is used, the indication shall not rely solely on sounds of different sound pressure level for perceptibility. Additional characteristics, such as tones or intermittence of the audible signals shall be used.

#### 4.2.3 Temperature and humidity dependence of the indication

There are two categories of *voltage detectors* according to climatic conditions of operation: normal (N) and special (S).

The *voltage detector* shall operate correctly in the temperature and humidity conditions of its climatic category as specified in Table 1. Climatic category N corresponds to absolute extreme values of type of climate “mild warm dry” as given in Table 3 of IEC 60721-2-1:2013. Climatic category S is an extension of temperature limits of climatic category N by 15 °C.

It may happen that extremely low temperature affects the audible indication but in all cases the audible indication shall be perceived.

**Table 1 – Climatic categories of voltage detectors**

| Climatic category |         | Ranges of climatic conditions for operation |                                               |                                                |
|-------------------|---------|---------------------------------------------|-----------------------------------------------|------------------------------------------------|
|                   |         | Temperature<br>°C                           | Highest temperature<br>with r.h. > 95 %<br>°C | Highest absolute humidity<br>g·m <sup>-3</sup> |
| (N)               | normal  | –15 to +45                                  | +31                                           | 30                                             |
| (S)               | special | –30 to +60                                  | +31                                           | 30                                             |

#### 4.2.4 Frequency dependency for a.c. voltage detector

A *voltage detector* designed for a.c. use shall operate correctly between 97 % and 103 % of each of its nominal frequencies.

#### 4.2.5 Ripple dependency for d.c. voltage detector

A *voltage detector* designed for d.c. use shall operate correctly when affected with a peak ripple factor of 4 %.

#### 4.2.6 Response time

The *response time* of the *voltage detector* shall be less than 1 s.

If the *response time* exceeds 500 ms, a statement indicating the *response time* shall be included in the instructions for use.

#### 4.2.7 Power source dependability

A *voltage detector* with an *internal energy source* shall give a *clear indication* until the source is exhausted, unless its usage is limited by an indication of non-readiness, as mentioned in the instructions for use.

#### 4.2.8 Testing element

*Voltage detectors* having *internal energy source* required for voltage detection, shall be equipped with a built-in *testing element*. In this case the *voltage detector* shall give an indication of "ready" or "not ready", according to the instructions for use.

For *voltage detectors* without *internal energy source*, the manufacturer shall make available a *testing element* either built-in or separate.

The *testing element* either built-in or separate shall be capable of testing all the electrical circuits, including energy source (if any), the functioning of the indication and the continuity of the *leads*. When all circuits cannot be tested, any limitation shall be clearly stated in the instructions for use. These circuits shall be constructed with high reliability.

Type and performance of such *testing elements* shall be explained in the instruction for use (see Annex C).

#### 4.2.9 Time rating

The *voltage detector* shall be able to perform properly during the specified *time rating* for the most severe voltage in normal operation. The minimum *time rating* shall be 30 s.

### 4.3 Electrical requirements

#### 4.3.1 Insulating material

The insulating materials shall be adequately rated (nature of material, dimensions) to withstand electrical stresses normally encountered in service.

Non-metallic enclosures that provide protection against hazard from electric shock shall have a material CTI rating of at least 400 according to IEC 60112.

According to 7.3.1.1 of IEC 61140:2001 for class II equipment, the *voltage detector* shall be so designed that the accessible conductive parts and the accessible surface of parts of insulating material shall either be

- separated from *hazardous live* parts by double or reinforced insulation, or
- designed with constructional arrangements providing equivalent protection, (e.g. a *protective impedance device*).

#### 4.3.2 Protection against electric shocks

Accessible parts shall not be hazardous. The battery compartment is not considered accessible if a tool is required to open it.

The insulation of the *voltage detector* shall be so rated that leakage current shall be limited under dry and humid conditions to:

- 0,5 mA rms or 2 mA d.c. in *normal conditions*,
- 3,5 mA rms or 10 mA d.c. in *single fault condition*,

according to the test procedure of 5.4.2.1.

If a failure could cause a hazard, the security of wiring connections subject to mechanical stresses shall not depend on soldering.

For safety purposes, the following materials shall not be used as insulation (see 6.7.1 of IEC 61010-031:2002):

- materials which can easily be damaged (for example, lacquer, enamel, oxides, anodic films);
- non-impregnated hygroscopic materials (for example, paper, fibres, fibrous materials).

#### 4.3.3 Current limiting elements

Current within the detecting circuit of the *voltage detector* shall be limited by impedance.

Fuses are not allowed in the voltage detection circuits; their use is only permitted for the continuity check function circuitry (see B.6).

#### 4.3.4 Minimum clearance and creepage distances

##### 4.3.4.1 General

Figure 1 illustrates typical applications of clearance and creepage distances related to a *voltage detector*.

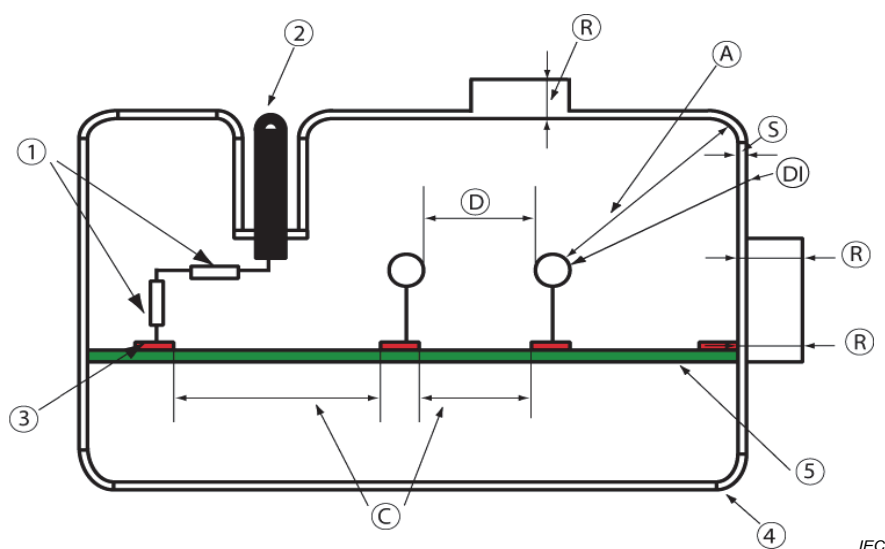


Figure 1a – Illustration of the electrical insulation of an indicator casing

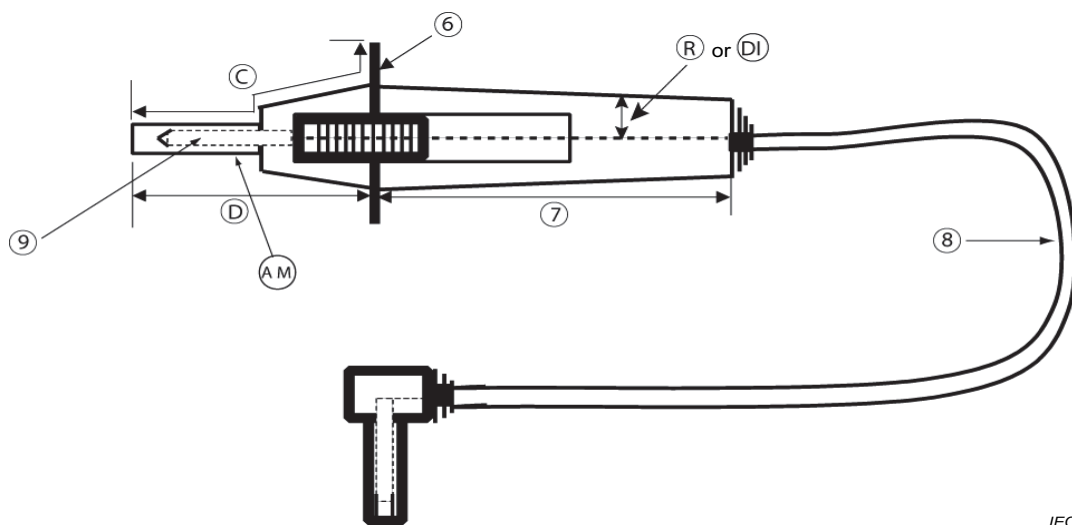


Figure 1b – Illustration of the electrical insulation of a probe with a detachable lead

**Key**

|   |                                                                                                     |    |                                                           |
|---|-----------------------------------------------------------------------------------------------------|----|-----------------------------------------------------------|
| 1 | <i>protective impedance</i> made of two current limiting elements or one high integrity element = R | 9  | <i>contact electrode</i>                                  |
| 2 | accessible conductive part                                                                          | A  | <i>basic insulation</i>                                   |
| 3 | copper track energized with the working voltage                                                     | AM | <i>basic insulation</i> at the minimum                    |
| 4 | enclosure                                                                                           | S  | supplementary insulation                                  |
| 5 | printed circuit board                                                                               | R  | reinforced insulation (more than one layer of insulation) |
| 6 | barrier                                                                                             | C  | creepage distances (along the surface)                    |
| 7 | hand-held area or <i>probe</i> body                                                                 | D  | clearance distance (in air)                               |
| 8 | <i>lead</i>                                                                                         | DI | double insulation A+S= DI                                 |

**Figure 1 – Illustration of the electrical insulation features applicable to components of a voltage detector**

**4.3.4.2 Clearance distances**

*Voltage detectors* shall be classified into overvoltage category III at least, according to IEC 60664-1.

Clearance distances for *basic insulation* and supplementary insulation shall meet the requirements of Table 2 according to nominal voltages and the overvoltage categories of the *voltage detectors*. This table is based on Table F.2 of IEC 60664-1:2007 – minimum clearance distances in air for inhomogeneous fields (case A).

Clearance distances for reinforced insulation shall meet the requirements of Table 3 according to nominal voltages and the overvoltage categories of the *voltage detectors*.

**Table 2 – Minimum clearance distances for basic insulation and for supplementary insulation**

| Voltage line to neutral derived from nominal voltages a.c. or d.c. up to and including V | Rated impulse voltage for category III V | Minimum clearance distance mm | Rated impulse voltage for category IV V | Minimum clearance distance mm |
|------------------------------------------------------------------------------------------|------------------------------------------|-------------------------------|-----------------------------------------|-------------------------------|
| 50                                                                                       | 800                                      | 0,2                           | 1 500                                   | 0,5                           |
| 100                                                                                      | 1 500                                    | 0,5                           | 2 500                                   | 1,5                           |
| 150                                                                                      | 2 500                                    | 1,5                           | 4 000                                   | 3,0                           |
| 300                                                                                      | 4 000                                    | 3,0                           | 6 000                                   | 5,5                           |
| 600                                                                                      | 6 000                                    | 5,5                           | 8 000                                   | 8,0                           |
| 1 000                                                                                    | 8 000                                    | 8,0                           | 12 000                                  | 14                            |

**Table 3 – Minimum clearance distances for reinforced insulation**

| Voltage line to neutral derived from nominal voltages a.c. or d.c. up to and including V | Rated impulse voltage for category III V | Minimum clearance distance mm | Rated impulse voltage for category IV V | Minimum clearance distance mm |
|------------------------------------------------------------------------------------------|------------------------------------------|-------------------------------|-----------------------------------------|-------------------------------|
| 50                                                                                       | 1 500                                    | 0,5                           | 2 500                                   | 1,5                           |
| 100                                                                                      | 2 500                                    | 1,5                           | 4 000                                   | 3                             |
| 150                                                                                      | 4 000                                    | 3                             | 6 000                                   | 5,5                           |
| 300                                                                                      | 6 000                                    | 5,5                           | 8 000                                   | 8                             |
| 600                                                                                      | 8 000                                    | 8                             | 12 000                                  | 14                            |
| 1 000                                                                                    | 12 000                                   | 14                            | 19 200 <sup>a</sup>                     | 24                            |

NOTE According to 5.1.6 of IEC 60664-1:2007: "Clearances for reinforced insulation are dimensioned as specified in Table F.2 [of IEC 60664-1:2007] corresponding to the rated impulse voltage but one step higher in the preferred series of values in 4.2.3 [of IEC 60664-1:2007] than that specified for *basic insulation*".

<sup>a</sup> According to 5.1.6 of IEC 60664-1:2007, when the impulse withstand voltage required for *basic insulation* is other than a value taken from the preferred series, reinforced insulation is dimensioned to withstand 160 % of the impulse withstand voltage required for *basic insulation* (19 200 V = 160 % of 12 000 V).

#### 4.3.4.3 Creepage distances

Creepage distances for basic and supplementary insulation shall be in accordance with Table F.4 of IEC 60664-1:2007. Values for reinforced insulation are twice the value for *basic insulation*.

Creepage distance shall always be at least as large as the value specified for clearance. If the determined creepage distance is smaller than the clearance, the creepage distance shall be increased to the value of the clearance.

Pollution degree inside the housing to be considered shall be 2. This value can be reduced in case of multilayers, coated or moulded circuits according to IEC 60664-3.

Pollution degree on the outer surface to be considered shall be minimum 2.

#### 4.3.5 Protection against electrical stresses

*Voltage detectors* shall withstand the electrical stresses likely to occur when applied to the installations for which they have been designed. These electrical stresses include:

- *transient overvoltages*,
- *temporary overvoltages*.

NOTE *Transient overvoltages* can be attributable to switching on the network, notably from capacitors and mostly from replacement of inductive loads and from lightning.

*Temporary overvoltages* can be attributable to defects, load shedding or resonance and/or ferro-resonance phenomena. Mostly, they result from surges which occur during an earth-fault.

#### 4.3.6 Lead(s)

The *leads* shall be rated for the maximum voltage and current expected during normal use of the *voltage detector*.

#### 4.3.7 Probes

The *probes* shall be rated for the maximum voltage and current expected during normal use of the *voltage detector*. Conductive parts shall be separated from the hand-held surface by double insulation or reinforced insulation (see Figure 1).

The *contact electrode* shall not have the construction of a hook for permanent connecting.

#### 4.3.8 Connector(s) (if any)

Connectors shall be designed in order to conform to 6.4.1 of IEC 61010-031:2002, elements a)i) and c)i).

#### 4.3.9 Accessible switches in the detecting circuit for temporary loading (if any)

Switches that allow temporary contact for loading shall be suitable for the maximum voltage and current expected during normal use of the *voltage detector*. The contact separation shall provide at least *basic insulation*. Conductive parts shall be separated from the hand-held surface by double or reinforced insulation.

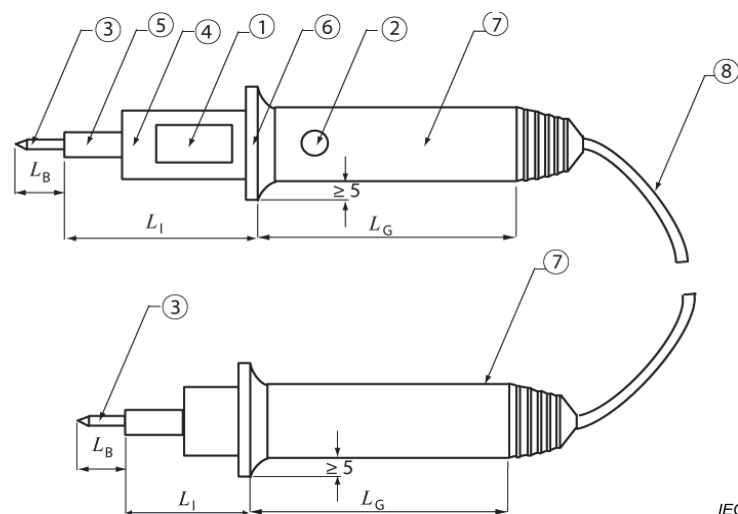
The actuating member of the switch shall withstand the operating forces during the *voltage detector* lifetime.

### 4.4 Mechanical requirements

#### 4.4.1 Design

The *voltage detector* shall consist of two *probes* with *lead(s)* and with one visual *indicator* (display). Each *probe* shall have one metallic *contact electrode*. Handles shall be equipped with a *hand-guard* (see Figure 2).

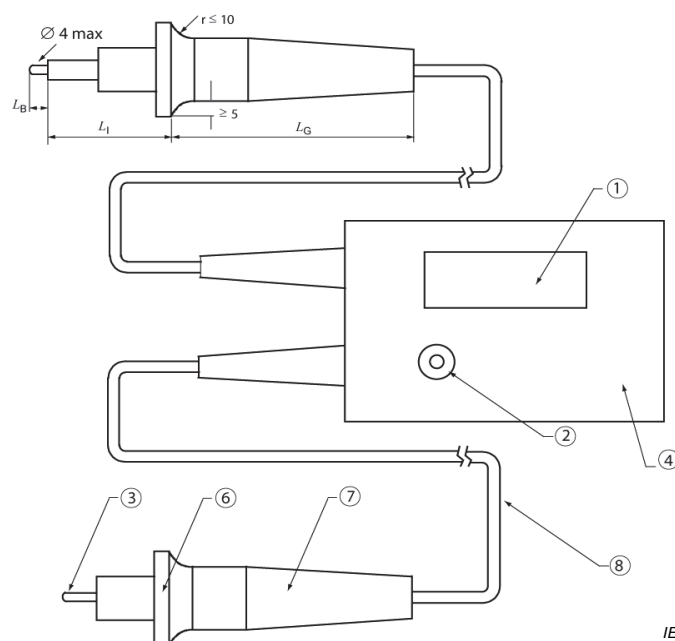
Dimensions in millimetres



IEC

Figure 2a – Example of a voltage detector with the indicator integrated in a probe

Dimensions in millimetres



IEC

Figure 2b – Example of a voltage detector with the indicator not integrated in a probe

## Key

|   |                                                    |       |                                                                                                   |
|---|----------------------------------------------------|-------|---------------------------------------------------------------------------------------------------|
| 1 | indicator                                          | 7     | probe                                                                                             |
| 2 | accessible conductive part                         | 8     | lead                                                                                              |
| 3 | non-insulated part of the <i>contact electrode</i> | $L_B$ | length of the non-insulated part of the <i>contact electrode</i>                                  |
| 4 | enclosure for <i>indicator</i>                     | $L_G$ | handle length                                                                                     |
| 5 | insulated part of the <i>contact electrode</i>     | $L_I$ | distance between the non-insulated part of the <i>contact electrode</i> and the <i>hand-guard</i> |
| 6 | <i>hand-guard</i>                                  |       |                                                                                                   |

Figure 2 – Voltage detector

The *voltage detector* shall be so designed that when in use, the two *contact electrodes* and the *indicator* are in the field of view of the user.

Crocodile clips are not allowed for *voltage detectors*.

#### 4.4.2 Dimensions, construction

The length  $L_B$  (see Figure 2) of the non-insulated part of the *contact electrode* shall be shorter than 19 mm.

The diameter of the non-insulated part of the *contact electrode* shall not exceed  $(4^{+0,5}_{-0})$  mm.

The distance  $L_I$  between the non-insulated part of the *contact electrode* in use and the *hand-guard* shall be at least 45 mm (see Figure 2).

The height of the *hand-guard* shall be at least 5 mm above the base of the handle and shall cover at least 50 % of the perimeter of the *probe* (see Figure 2).

When accessible conductive parts are provided, they shall be designed to avoid short circuit or electric shock. They shall not be placed between the *contact electrode* and the *hand-guard*. The maximum dimension of the conductive surface, measured in any direction, shall not exceed 19 mm.

The handle shall have a length  $L_G$  of at least 70 mm (see Figure 2).

#### 4.4.3 Degree of protection provided by enclosures

The correct functioning of the *voltage detector* shall not be affected by dust and water ingress.

The degree of protection of all the enclosures of the *voltage detector* shall meet at least the requirements for IP54 for category 2 equipment (see IEC 60529) except the following:

- for *leads* that can be detached, the disconnect points shall have a degree of protection of at least IP2X (see 4.4.11);
- when existing, mechanical active parts of a *probe* located in front of the hand guard (e.g; cursor, sliding shroud, covers, etc.) shall have a degree of protection of at least IP2X.

#### 4.4.4 Resistance to vibration

The *voltage detector* shall withstand sinusoidal rectilinear vibrations as specified in 5.5.4.

#### 4.4.5 Drop resistance

The *voltage detector* shall withstand drops as specified in 5.5.5.

#### 4.4.6 Shock resistance

The *voltage detector* shall withstand mechanical shocks as specified in 5.5.6.

#### 4.4.7 Possible disassembling

It shall not be possible to disassemble the enclosures of the *voltage detector*, or there shall be clear provision (e.g. sealing, plomb) that disassembly has occurred. This does not apply to battery compartments or the connections of *leads*.

The opening of the battery box shall not cause any danger. All the assembling features shall be captive.

#### 4.4.8 Surface temperature

Easily touched surfaces shall not exceed the temperature values specified in 5.5.8 under normal and *single fault condition*, under the maximum ambient temperature according to the climatic category of the *voltage detector*.

#### 4.4.9 Resistance to heat

Parts of enclosures of a *voltage detector* made of insulating materials shall have adequate resistance to heat.

#### 4.4.10 Probes

*Probes* shall comply with the mechanical requirements of IEC 61010-031.

The insulated parts of the *contact electrodes* shall support a test for the close adhesion of the insulating material.

NOTE For the requirements of maximum length and diameter of the *contact electrode*, see 4.4.2.

#### 4.4.11 Lead(s)

In addition to the normal service stresses of the *voltage detector*, the *leads* shall withstand specific normal service stresses.

Flexible single core *leads* shall have a conductor cross-sectional area of not less than 0,75 mm<sup>2</sup>. Multi-core *leads* shall have a total conductor cross-section of at least 1,0 mm<sup>2</sup>.

The attachment of the *lead* shall withstand forces likely to be encountered in normal use without damage which could cause a hazard.

Solder alone, without mechanical gripping, shall not be used for strain relief.

The insulation of the *lead* shall be mechanically secured to avoid retraction.

For detachable *leads*, the design of the connector which plugs into the *indicator* shall have an IP2X degree of protection female connector. Additionally, all other disconnect points require at least an IP2X degree of protection.

For detachable *leads*, the design of the connector shall avoid the *lead* to be displaced too much from the *indicator* casing under pull stress.

### 4.5 Marking

#### 4.5.1 General

The marking shall be durable and readily legible to a person with normal or corrected vision without additional magnification.

#### 4.5.2 Marking on the indicator

The *indicator* shall have the following items of marking with a height of letter equal to at least 3 mm:

- maximum nominal voltage;
- symbol IEC 60417-5216 (2002-10) – Suitable for live working; double triangle – and number of the relevant IEC standard (IEC 61243-3) adjacent to the symbol;

NOTE 1 The exact ratio of the height of the figure to the base of the triangle is 1,43. For the purpose of convenience, this ratio can be between the values of 1,4 and 1,5.

- overvoltage category adjacent to the maximum voltage to neutral according to IEC 60664-1;
- “a.c. voltage” or symbol IEC 60417-5032 (2002-10) – Alternating current including nominal frequency(ies) or frequency range, if any;
- “d.c. voltage” or symbol IEC 60417-5031 (2002-10) – Direct current, if any;
- “a.c./d.c. voltage” or symbol IEC 60417-5033 (2002-10) – Both direct and alternative current, if any;
- internal impedance at ELV a.c. "X kΩ @ ELV a.c.";  
"X kΩ / Y kΩ @ ELV a.c";  
with X and Y the internal impedance values in kΩ measured in 5.3.1.3.1

Only *voltage detectors* passing the performance test according to 5.3.1.4.3.1 are allowed to declare two values of internal impedance.

Additionally each *indicator* shall have at least the following items of marking but with a smaller height of letter in ratio of 2 with the previous marking and with a minimum height of 1,5 mm:

- indication of nominal voltage(s) or nominal voltage range(s);
- if necessary, two or three voltage values or one range or other information (e.g. in form of symbols according to IEC 60417 and ISO 7000) shall be given one below the other and on the right of the graphical symbol;
- mark of origin (name or trade mark of the manufacturer);
- peak value of the maximum occurring current of all built-in indicating systems  $I_s \geq 3,5$  mA, measured within 30 s at the highest nominal voltage or the highest voltage of the nominal voltage range;

NOTE 2 The current flowing through the *voltage detector* may influence the behaviour of the installation under test.

- year of manufacture;
- temperature range ... °C; optionally the climatic category;
- type designation;
- *time rating and recovery time*;
- degree of protection by enclosure (IP);
- indication of the battery type to be used on or in the battery box;
- symbol ISO 7000-0434 (2004-01) – Caution.

With every *voltage detector* or with every batch of *voltage detectors* to be delivered, the manufacturer shall provide information related to the number of the IEC standard with the year of publication.

#### 4.5.3 Marking on the probe and/or the lead

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

Additional information, such as serial numbers, batch numbers, etc. may be added.

#### 4.6 Instructions for use

Each *voltage detector* shall be accompanied by the manufacturer's instructions for use (see Annex C). These instructions shall be prepared in accordance with the general provisions given in IEC 61477.

## 4.7 Requirements in case of reasonably foreseeable misuse during live working

### 4.7.1 AC/DC voltage misuse

For *voltage detectors* designed only for a.c., the presence of d.c. voltage exceeding the ELV limit shall be indicated.

For *voltage detectors* designed only for d.c., the presence of a.c. voltage exceeding the ELV limit shall be indicated.

### 4.7.2 Maximum current to earth in case of misuse

In accordance with the values included in Figures 20 and 22 of IEC TS 60479-1:2005, and introducing a supplementary safety margin for the permissible current, the maximum current to earth in case of misuse shall not exceed line B of Figure 3 for alternating current and line B of Figure 4 for direct current as measured according to the test procedure of 5.8.2.

NOTE For additional information on the current zones (AC-1, DC-1, etc.) and the physiological effects, see Tables 11 and 13 of IEC/TS 60479-1:2005.

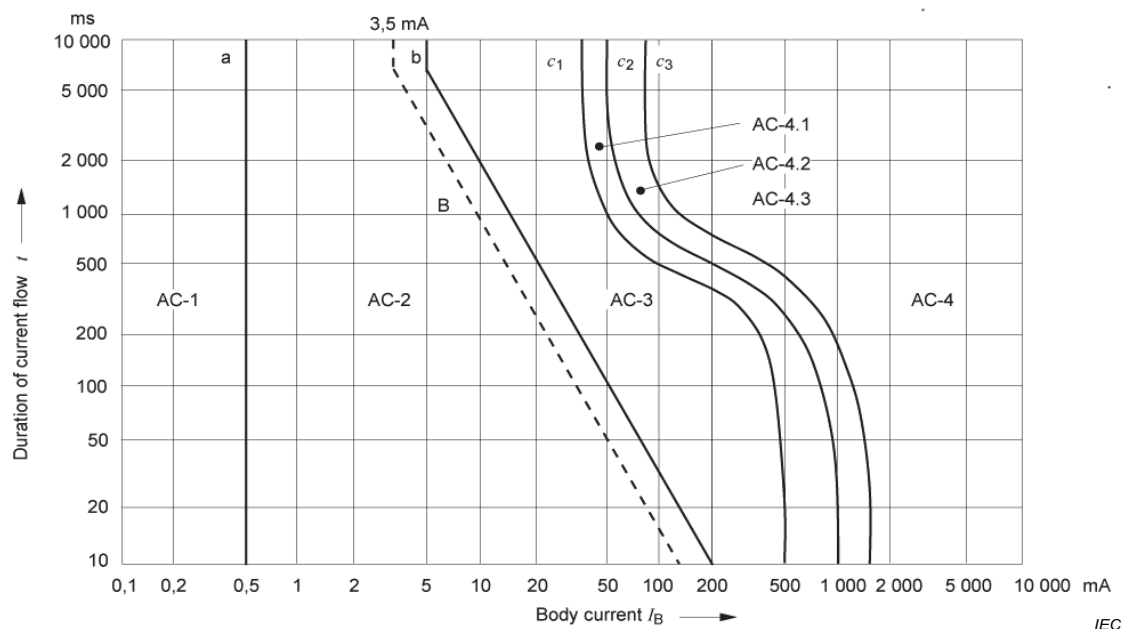


Figure 3 – Maximum rms a.c. current to earth in case of misuse

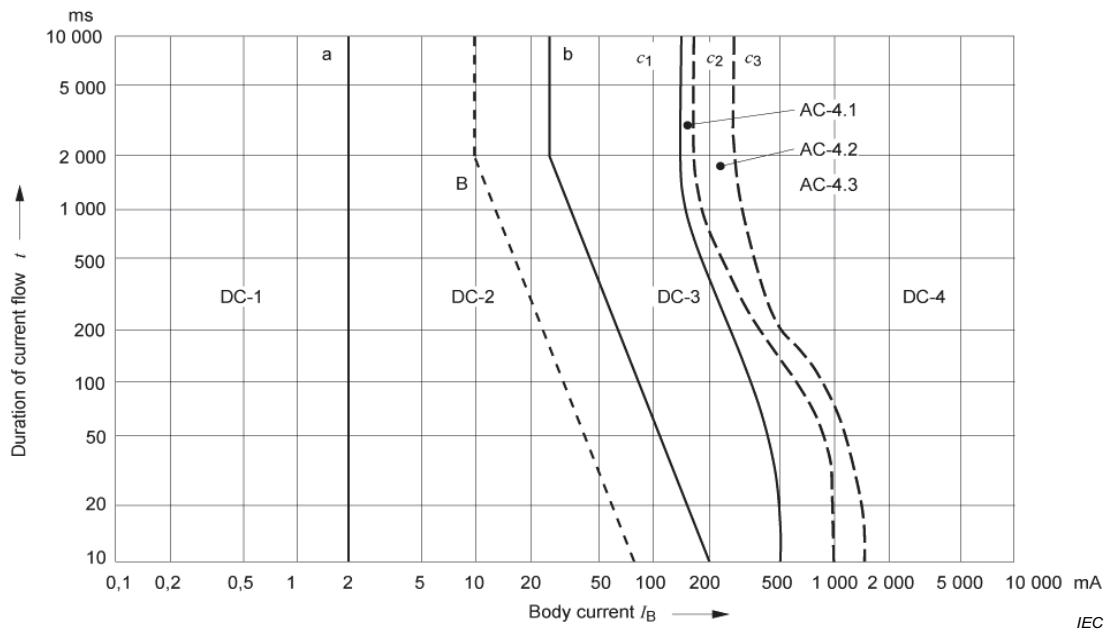


**Figure 4 – Maximum d.c. current to earth in case of misuse**

In case of misuse, *voltage detectors* that may have currents to earth exceeding the values given above shall have additional protective means for avoiding hazardous inadvertent access to the *contact electrodes*. Both hands shall be involved for actuating these protection means. These protection means could consist for example in:

- IP2X protection of each of the *contact electrodes* (see IEC 60529) when they are not in use;
- an indicating circuit activated by two switches that allow temporary contact for loading, one in each *probe* with no parallel path delivering more than 3,5 mA.

#### 4.7.3 Misuse in case of mistaking of the voltage of the low voltage network

In the event of mistaking the voltage of the low voltage network, application of low voltages between the *contact electrodes*, irrespective of the nominal voltage or nominal voltage range of the *voltage detector* shall not result in a short circuit or any other failure likely to cause electric shock or burns to the user.

## 5 Tests

### 5.1 General

The present standard provides testing provisions to demonstrate compliance of the product to the requirements of Clause 4. These testing provisions are primarily intended to be used as type tests for validation of the design input. Where relevant, alternative means (calculation, examination, tests, etc.), are specified within the test subclauses for the purpose of *voltage detectors* having completed the production phase.

Annex D specifies the list of type tests to be performed within a sequential order and the type tests to be performed out of sequence.

Each type test within the sequential order shall be performed on the same three *voltage detectors*.

Three additional *voltage detectors* or test pieces shall be used to perform each type test out of sequence, except for 5.2.2 which is performed on only one *voltage detector*.

If more than one *voltage detector* does not pass, the test has failed. If only one *voltage detector* fails, the entire sequence for the type tests shall be repeated on three other *voltage detectors*. If, again, any of the *voltage detectors* does not pass, the type test is considered to have failed. In the particular case of 5.2.2, if the *voltage detector* does not pass, the type test is considered to have failed.

Tests under *single fault conditions* shall comply with 4.4 of IEC 61010-1.

If tests under fault conditions may be destructive, these tests may follow those under reference test conditions.

Unless otherwise specified in the individual test subclauses the following apply.

- The functional tests shall be performed at the nominal frequency of the *voltage detector*. For a *voltage detector* with more than one nominal frequency or a nominal frequency range, the tests shall be performed at the minimum and maximum nominal frequencies.
- The tests shall be carried out at an ambient temperature of  $(23 \pm 5) ^\circ\text{C}$  and at a relative humidity between 30 % and 75 %.
- The *voltage detectors* for type tests shall be stored at an ambient temperature of  $(23 \pm 5) ^\circ\text{C}$  for at least 5 h before the test procedure is started.
- The alternating currents and alternating voltages specified for the tests are given in rms values.
- For the test at d.c. voltage, a voltage source with a peak ripple not exceeding 1 % shall be used.
- The accuracy for the measurement of the following parameters shall be:
  - test voltage (a.c./d.c.):  $\pm 3$  %
  - test voltage (impulse):  $\pm 5$  %
  - current:  $\pm 1,5$  %
  - frequency:  $\pm 0,2$  %
  - temperature:  $\pm 2$  K
  - relative humidity:  $\pm 3$  %
  - time of impulse voltage:  $\pm 20$  %
  - time (test duration)  $\pm 1$  %
- For dimensions of the *voltage detector*, a tolerance of  $\pm 0,1$  mm shall be used.
- The dimensions of the test set-ups shall comply with Js18 level according to ISO 286-1 and ISO 286-2.

## 5.2 Tests for general requirements

### 5.2.1 Indication

The requirements for indication shall be checked by *inspection*. This *inspection* shall verify the change of status of each visual and audible (if any) signal by suitable voltage application.

The *inspection* shall be considered as passed if the requirements of 4.1.2 are fulfilled.

### 5.2.2 Electromagnetic compatibility (EMC)

#### 5.2.2.1 Type test

*Voltage detectors* shall be submitted to and shall fulfil the relevant tests of IEC 61326-1:2005 for:

- immunity requirements for equipment intended for use in industrial locations (Table 2 and Annex A of IEC 61326-1:2005), and
- emission limit requirements of class A equipment (7.2 of IEC 61326-1:2005).

The *voltage detector* shall be configured in a mode that represents normal working conditions according to the instructions for use.

During the tests, the *voltage detector* shall be connected to a voltage source (a.c. and/or d.c. according to the type of *voltage detector*) adjusted first at the corresponding ELV value and followed by a test at the maximum nominal voltage of the *voltage detector*.

The test shall be considered as passed if the relevant indications are not affected.

### 5.2.2.2 Alternative means for voltage detectors having completed the production phase

After completing the production phase, it is not practical to perform EMC tests for checking the conformity to the relevant requirements. Nevertheless, the manufacturer shall prove that he has followed the same documented assembly procedure as per the type tested device.

The manufacturer shall document components that could affect the EMC.

## 5.3 Tests for functional requirements

### 5.3.1 Clear indication

#### 5.3.1.1 Threshold voltage

##### 5.3.1.1.1 Setting and scale change

It shall be checked by *inspection* that

- the user has no access to the *threshold voltage* setting, and
- any switches used for scale change are not accessible.

##### 5.3.1.1.2 Threshold voltage value(s)

The *contact electrodes* of the *voltage detector* shall be connected to a voltage source (a.c. or d.c., according to the type of *voltage detector*).

The test voltage shall be increased and each voltage value corresponding to a change of the status of the signal shall be noted.

The test shall be considered as passed if the voltage value(s) fulfill the requirements of 4.2.1.1 for the *threshold voltage(s)*.

For an a.c./d.c. *voltage detector*, the test shall be performed for each type of voltage.

### 5.3.1.2 ELV indication

#### 5.3.1.2.1 Type test

For *voltage detectors* with an *internal energy source*, the source shall be removed before the test.

The *contact electrodes* of the *voltage detector* shall be connected to a voltage source (a.c. or d.c., according to the type of *voltage detector*). The voltage source shall be set at the ELV voltage value within a permissible tolerance of  $\pm 5\%$ .

The test shall be carried out with and without activation of the switches for temporary loading (if any).

For *voltage detectors* employing overcurrent protective devices, the test consists of circulating in the detecting circuit a current sufficient to operate the protection, immediately followed by verification of the ELV indication.

The test shall be considered as passed if the ELV indication appears in all cases.

For an a.c./d.c. *voltage detector*, the test shall be performed for each type of voltage.

#### **5.3.1.2.2 Alternative test in case of voltage detectors with internal energy source having completed the production phase**

In case of *voltage detector* with *internal energy source*, the alternative test consists in performing the type test of 5.3.1.2.1 without removing the *internal energy source*.

#### **5.3.1.3 Measurement of the internal impedance for the a.c. power frequency value of the ELV**

##### **5.3.1.3.1 Type test**

The following test shall be performed on all *voltage detectors* (a.c. and/or d.c.) under a.c. condition only.

The *contact electrodes* of the *voltage detector* shall be connected to an a.c. voltage source in series with an ammeter. The voltage source shall be set at the ELV voltage value within a permissible tolerance of  $\pm 5\%$ . The current value(s) shall be recorded and the internal impedance(s) of the *voltage detector* shall be calculated.

The measurement shall be repeated for the different internal impedance loads (if more than one), for example with and without activation of the switches for temporary loading (if any).

NOTE One functioning principle of a *voltage detector* claiming to be able to distinguish an operating voltage from an *interference voltage* is based on a switching between two values of internal impedance.

#### **5.3.1.3.2 Alternative means in case of voltage detectors having completed the production phase**

The manufacturer shall prove that he has followed the same documented assembly procedure as per the type tested device.

The manufacturer shall document components that could affect the performance of the *voltage detector* with regard to its internal impedance(s).

#### **5.3.1.4 Continuous indication**

##### **5.3.1.4.1 Indication only in contact with bare part**

The test voltage shall be set at the maximum nominal voltage of the *voltage detector*.

One *contact electrode* of the *voltage detector* shall be connected to one pole of the voltage source (a.c. or d.c., according to the type of *voltage detector*). The other *contact electrode* shall be moved slowly toward the second pole of the voltage source until it is within 2 mm of making contact.

The test shall be considered as passed if there is no indication of the presence of an *indicating voltage*. The ELV indication is permitted.

For an a.c/d.c *voltage detector*, the test shall be performed for each type of voltage.

#### 5.3.1.4.2 Influence of electromagnetic field

The tests for influence of electromagnetic field are included in the tests of 5.2.2 for electromagnetic compatibility.

NOTE IEC 61326-1:2005, Annex A for immunity requirements for equipment intended for use in industrial locations includes a test for the immunity to power frequency magnetic field (Table 2 of IEC 61326-1:2005).

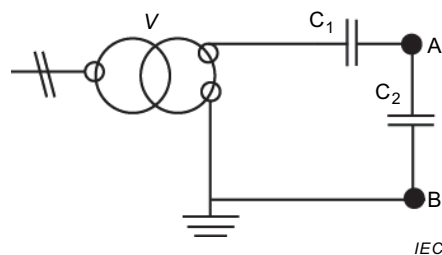
#### 5.3.1.4.3 Performance of voltage detector claiming to be able to distinguish an operating voltage from an interference voltage

##### 5.3.1.4.3.1 Type test

The following test shall be performed on a *voltage detector* claiming to be able to distinguish an operating voltage from an *interference voltage*.

The a.c. test set-up simulates the particular situation where two low-voltage power cables (95 mm<sup>2</sup> or AWG 4/0 cables) are installed very close (i.e.: in a same earthed cable support system, cables in parallel or twisted together), on a distance of 50 m.

The *voltage detector* shall be connected between point A and point B of the test set-up specified in Figure 5. The a.c. test voltage shall correspond to the maximum nominal voltage of the *voltage detector*.



#### Key

|                |                                                                                           |
|----------------|-------------------------------------------------------------------------------------------|
| V              | test voltage                                                                              |
| A and B        | test points                                                                               |
| C <sub>1</sub> | capacitor of 1 500 pF representing the capacitive coupling between the two power cables   |
| C <sub>2</sub> | capacitor of 3 900 pF representing the capacitance of the disconnected cable to be tested |

**Figure 5 – Test set-up for the performance of a voltage detector claiming to be able to distinguish an operating voltage from an interference voltage**

The test shall be considered as passed if the presence of an *interference voltage* is confirmed either by a direct or indirect indication.

NOTE An indirect indication is an information assisting the user in the deduction of the presence of an *interference voltage*. For example a device with manual load switching.

#### 5.3.1.4.3.2 Alternative means in case of voltage detectors having completed the production phase

The manufacturer shall prove that he has followed the same documented assembly procedure as per the type tested device.

The manufacturer shall document components that could affect the performance of the *voltage detector* with regard to the influence of an *interference voltage*.

### 5.3.1.5 Successive indication

The test for successive indication can be combined with the test for *threshold voltage* values by verifying additionally that the level indication fulfill the requirements of 4.2.1.4 when decreasing the test voltage.

### 5.3.2 Clear perceptibility of visual indication

#### 5.3.2.1 Type test

The test shall be performed at the ELV limit and at a test voltage of 0,85 times the nominal voltage or 0,85 times the particular step within the nominal voltage range and at 0,85 times the lower nominal voltage of the nominal voltage range under a.c. or d.c. voltage. For an a.c./d.c. *voltage detector*, the test shall be performed for each type of voltage. The permissible tolerance of the test voltage shall be  $\pm 5\%$ .

For a *voltage detector* having an *internal energy source*, it shall be discharged until the non-readiness indication appears as mentioned in the instructions for use. The test duration may be reduced by supplying the *voltage detector* with an external power source with a sufficient energy level.

The *voltage detector* shall be placed in a room with low light reflection and so clamped that it can be turned around a horizontal axis at the display of the *indicator* and can be rotated around its longitudinal axis. At a distance of 150 mm behind the horizontal turning axis, a matt grey surface with identification colour IEC 60304 'grey' (for example, a painted wall or paper screen) with a diameter of at least 500 mm shall be arranged vertically in the room in such a way that its centre is behind the *indicator* of the *voltage detector*.

The *voltage detector* and the matt grey surface shall be lit by a diffuse white light from two halogen light sources, placed at least 1 m from the *voltage detector*, in accordance with Figure 6. The arrangement shall be such that the light reflected from the matt grey surface to the *indicator* of the *voltage detector* has an illumination of 3 500 lx. For *voltage detectors* with a nominal voltage or nominal voltage range starting below the ELV limit indication, the illumination shall also be 3 500 lx for the indicating range <50 V.

At a distance of 750 mm from the *voltage detector*, the forehead stop for the observer shall be arranged, as shown by item 5 in Figure 6.

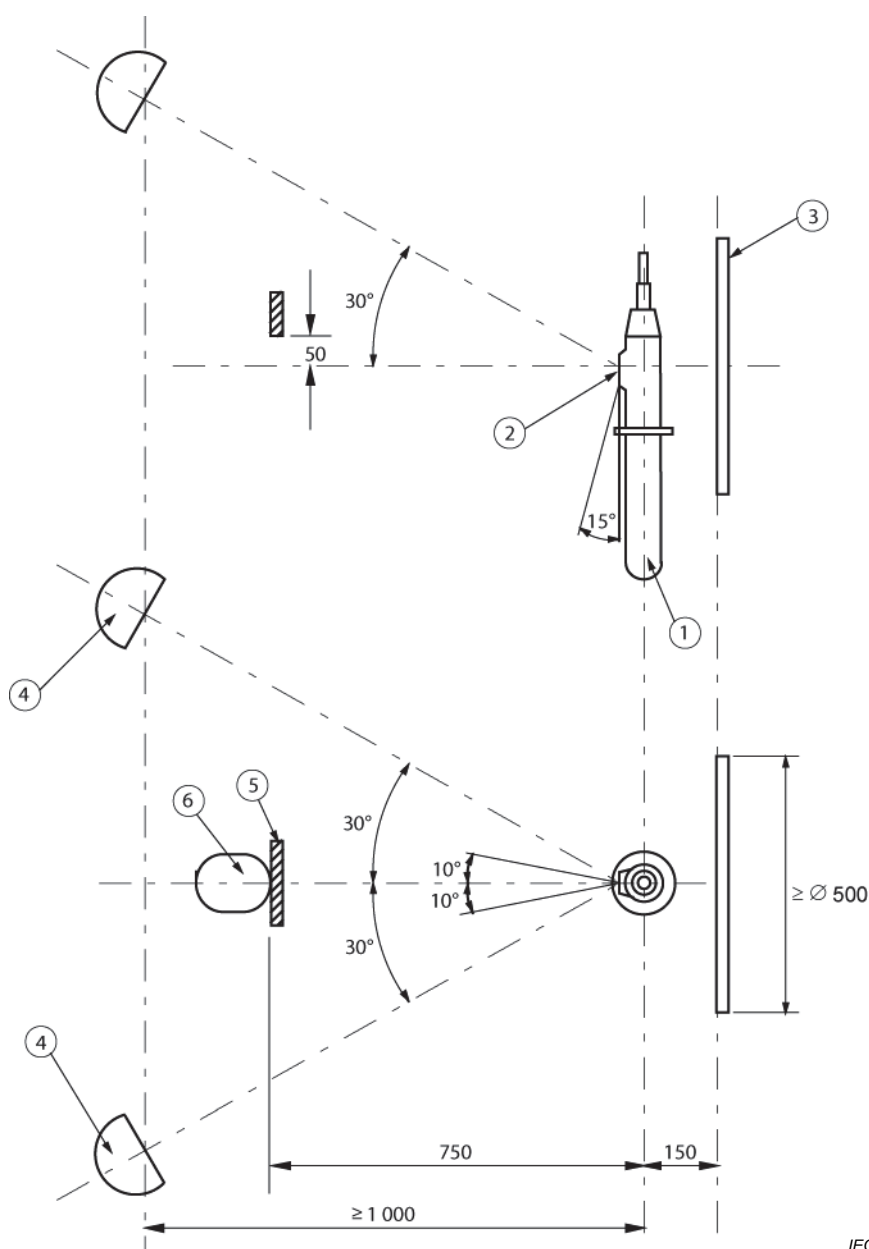
The *voltage detector* shall be rotated from the original vertical position to an angle of 15° and back to the original position, the display of the *indicator* being turned by rotation around the longitudinal axis of the detector by an angle of 10° to the right and to the left in order to identify the most unfavourable position of the indication.

The test shall be carried out consecutively by three observers with average sight. The observer places his forehead against the forehead stop. Voltage shall then be applied between the two *contact electrodes* of the *voltage detector* with the display of the *indicator* in the most unfavourable position.

The test voltage shall be connected and disconnected several times at irregular time intervals, unknown by the observer.

The test shall be considered as passed if each of the three observers clearly sees each visual indication.

Dimensions in millimetres



IEC

#### Key

- 1 voltage detector
- 2 display of the indicator
- 3 area with matt grey surface
- 4 light source
- 5 forehead stop
- 6 observer

**Figure 6 – Test set-up for measurement of clear perceptibility of visual indication**

#### 5.3.2.2 Alternative test in case of voltage detectors having completed the production phase

The alternative test consists of comparing the perceptibility of the visual indication of a *voltage detector* having completed the production phase to the one of a *voltage detector* which has passed successfully the type test according to 5.3.2.1 (reference *voltage detector*).

### 5.3.3 Clear perceptibility of audible indication (when available)

#### 5.3.3.1 Type test

The test shall be performed at the ELV limit and at a test voltage of 0,85 times the nominal voltage or 0,85 times the particular step within the nominal voltage range and at 0,85 times the lower nominal voltage of the nominal voltage range under a.c. or d.c. voltage. For an a.c./d.c. *voltage detector*, the test shall be performed for each type of voltage. The permissible tolerance of the test voltage shall be  $\begin{smallmatrix} 0 \\ -5 \end{smallmatrix} \%$ .

For a *voltage detector* having an *internal energy source*, it shall be discharged until the non-readiness indication appears as mentioned in the instructions for use. The test duration may be reduced by supplying the *voltage detector* with an external power source with a sufficient energy level.

Sound pressure levels shall be measured according to the specifications of ISO 3744, in terms of the main requirements (grade 2 accuracy, measurement surface, microphone positions, background noise, etc.), except for the fact that the measurements are carried out in a free-field, without the reflecting plane referred to in ISO 3744.

The absorption coefficient of the environment shall be at least 0,9 Hz at 700 Hz (see ISO 354). The measurement may be carried out in an anechoic room duly compliant with ISO 3745; in this case, the required absorption conditions are naturally fulfilled. In a semi-anechoic room or any other free-field over a reflecting plane environment in accordance to ISO 3744, the absorption of the reflecting plane can generally be obtained by covering this surface with a sound absorbing material approximately 20 cm thick and with a minimum surface area of 2,0 m × 2,0 m.

In addition, the background noise level of the room shall be at least 6 dB, and preferably more than 15 dB, below the noise of the *voltage detector* under test, within the frequency range of interest.

The instrumentation system, including the microphone and related cables, shall meet the requirements for a type 1 instrument as specified in IEC 61672-1 for sound level meters (required for continuous signal) or, for integrating-averaging sound level meters (required for intermittent sounds). The filters used shall meet the requirements for a class 1 instrument specified in IEC 61260.

During each series of measurements, a sound calibrator with an accuracy of class 1 specified in IEC 60942 shall be applied to the microphone to verify the calibration of the entire instrument system.

The measuring surface shall be a hemisphere with a radius  $r = 1$  m and with ten microphone positions. The *voltage detector* under test shall be installed so that the sound transmitter is oriented towards point 10. The sound transmitter shall coincide with the centre of the coordinates system of the hemispherical measurement surface (see Figure 7) and shall be at least 250 mm above the absorption surface on the floor (for example 250 mm above the sound absorbing material when the measurements are carried out in a modified semi-anechoic room).

The sound pressure level shall be measured within the frequency range 1 000 Hz to 4 000 Hz, with the A-weighting network. Before starting measurements, it shall be checked that the *voltage detector* under test radiates predominantly within this frequency range. The A-weighted time-averaged sound pressure level shall be measured, for intermittent or continuous sound emission, at each microphone position (points 1 to 10 as described in Figure 7). If the difference between the sound pressure level measured with the *voltage detector* under test and the background noise level is between 6 dB and 15 dB, corrections shall be applied to the measurement values, in accordance with 8.3 of ISO 3744. The A-

weighted sound pressure levels are then averaged over the measurement surface (point 1 to 10) according to 8.1 of ISO 3744.

Dimensions in millimetres

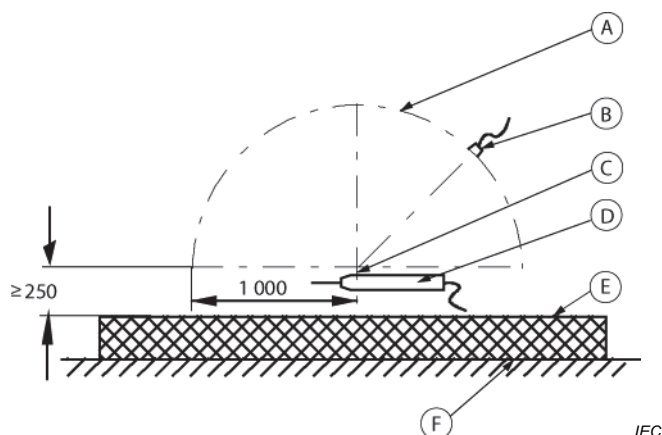
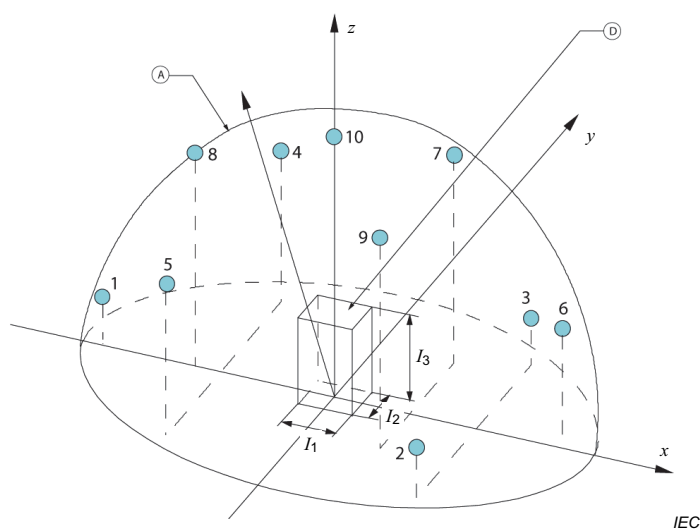


Figure 7a – Positioning of the voltage detector in the test set-up



| Microphone position | $x/r$ | $y/r$ | $z/r$ | Microphone position | $x/r$ | $y/r$ | $z/r$ |
|---------------------|-------|-------|-------|---------------------|-------|-------|-------|
| 1                   | -0,99 | 0     | 0,15  | 6                   | 0,89  | 0     | 0,45  |
| 2                   | 0,50  | -0,86 | 0,15  | 7                   | -0,33 | 0,57  | 0,75  |
| 3                   | 0,50  | 0,86  | 0,15  | 8                   | -0,66 | 0     | 0,75  |
| 4                   | -0,45 | 0,77  | 0,45  | 9                   | 0,33  | -0,57 | 0,75  |
| 5                   | -0,45 | -0,77 | 0,45  | 10                  | 0     | 0     | 1,0   |

Figure 7b – Key measurement points on the hemisphere

**Key**

- |   |                                |   |                          |
|---|--------------------------------|---|--------------------------|
| A | hemisphere measurement surface | D | voltage detector         |
| B | microphone                     | E | sound absorbing material |
| C | sound transmitter              | F | mounting surface         |

Figure 7 – Test set-up for measurement of clear perceptibility of audible indication