BS EN 61243-3:2014
Incorporating corrigendum January 2015

BSI Standards Publication

Live working — Voltage detectors

Part 3: Two-pole low-voltage type

National foreword

This British Standard is the UK implementation of EN 61243-3:2014. It is identical to IEC 61243-3:2014, incorporating corrigendum January 2015. It supersedes BS EN 61243-3:2010, which will be withdrawn on 13 November 2017.

The UK participation in its preparation was entrusted to Technical Committee PEL/78, Tools for live working.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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EUROPEAN STANDARD

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EN 61243-3

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English Version

Live working - Voltage detectors - Part 3: Two-pole low-voltage type (IEC 61243-3:2014)

Travaux sous tension - Détecteurs de tension - Partie 3: Type bipolaire basse tension (CEI 61243-3:2014)

Arbeiten unter Spannung - Spannungsprüfer - Teil 3: Zweipoliger Spannungsprüfer für Niederspannungsnetze (IEC 61243-3:2014)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 78/1054/FDIS, future edition 3 of IEC 61243-3, prepared by IEC/TC 78 "Live working" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61243-3:2014.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2015-08-13
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2017-11-13

This document supersedes EN 61243-3:2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

Endorsement notice

The text of the International Standard IEC 61243-3:2014 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60721-2-1:1982 & IEC 60721-2-1:1982/A1:1987	NOTE	Harmonized as HD 478.2.1 S1:1989 (not modified).
IEC 60743:2013	NOTE	Harmonized as EN 60743:2013 (not modified).
ISO 9000:2005	NOTE	Harmonized as EN ISO 9000:2005 (not modified).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60068-2-6	-	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	EN 60068-2-6	-
IEC 60068-2-31	-	Environmental testing - Part 2-31: Tests - Test Ec: Rough handling shocks, primarily for equipment-type specimens	EN 60068-2-31	-
IEC 60068-2-75	1997	Environmental testing - Part 2-75: Tests - Test Eh: Hammer tests	EN 60068-2-75	1997
IEC 60112	-	Method for the determination of the proof and the comparative tracking indices of solid insulating materials	EN 60112	-
IEC 60304	-	Standard colours for insulation for low-frequency cables and wires	HD 402 S2	-
IEC 60417	-	Graphical symbols for use on equipment	-	-
IEC/TS 60479-1	2005	Effects of current on human beings and livestock - Part 1: General aspects	-	-
IEC 60529 - + A1 + A2	1989 - 1999 2013	Degrees of protection provided by enclosures (IP Code)	EN 60529 + corrigendum May + A1 + A2	1991 1993 2000 2013
IEC 60664-1	2007	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests	EN 60664-1	2007
IEC 60664-3	-	Insulation coordination for equipment within low-voltage systems - Part 3: Use of coating, potting or moulding for protection against pollution	EN 60664-3	-

Publication	Year	Title	EN/HD	Year
IEC 60695-10-2	2003	Fire hazard testing - Part 10-2: Abnormal heat - Ball pressure test	EN 60695-10-2	2003
IEC 60942	-	Electroacoustics - Sound calibrators	EN 60942	-
IEC 61010-1 -	2001 [1)] -	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements	EN 61010-1 + corrigendum Jun.	2001 [2)] 2002
IEC 61010-031 + A1	2002 2008	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	EN 61010-031 + A1	2002 2008
IEC 61140 + A1 (mod)	2001 2004	Protection against electric shock - Common aspects for installation and equipment	EN 61140 + A1	2002 2006
IEC 61180-1	-	High-voltage test techniques for low-voltage equipment - Part 1: Definitions, test and procedure requirements	EN 61180-1	-
IEC 61180-2	-	High-voltage test techniques for low-voltage equipment - Part 2: Test equipment	EN 61180-2	-
IEC 61260	-	Electroacoustics - Octave-band and fractional-octave-band filters	EN 61260	-
IEC 61318	-	Live working - Conformity assessment applicable to tools, devices and equipment	EN 61318	-
IEC 61326-1	2005	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements	EN 61326-1	2006
IEC 61477	-	Live working - Minimum requirements for the utilization of tools, devices and equipment	EN 61477	-
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	EN 61557-7	2007
IEC 61672-1	-	Electroacoustics - Sound level meters - Part 1: Specifications	EN 61672-1	-

1) Superseded by IEC 61010-1:2010.

2) Superseded by EN 61010-1:2010 (IEC 61010-1:2010).

Publication	Year	Title	EN/HD	Year
ISO 286-1	-	Geometrical product specifications (GPS) - ISO code system for tolerances on linear sizes - Part 1: Basis of tolerances, deviations and fits	EN ISO 286-1	-
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	EN ISO 286-2	-
ISO 354	-	Acoustics - Measurement of sound absorption in a reverberation room	EN ISO 354	-
ISO 3744	1994 [3)]	Acoustics - Determination of sound power levels of noise sources using sound pressure - Engineering method in an essentially free field over a reflecting plane	EN ISO 3744	2009 [4)]
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	EN ISO 3745	-
ISO 7000	-	Graphical symbols for use on equipment - Registered symbols	-	-

3) Superseded by ISO 3744:2010.

4) Superseded by EN ISO 3744:2010 (ISO 3744:2010).

CONTENTS

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 detector*s with their accessories (crocodile clips and detachable *lead*s) 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[1]

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[2]

IEC 61010-1:2001[3], *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*

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

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

3 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[4], *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 electrode*s

4 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 voltage*s 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 electrode*s

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 electrode*s 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 *probe*s, an *indicator* included or not in one of the *probe*s 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 detector*s covered by this standard shall be designed and manufactured in order to contribute to the safety of the users, provided the *voltage detector*s 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 detector*s 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 detector*s 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 $1{,}1\,U_{i(step-1)}$ and $0{,}85\,U_{i(step)}$;
– of each step of *indicating voltage* range (U_i min, U_i max) shall be limited to the interval included between $1{,}1\,U_{i(step-1)}$ max and $0{,}85\,U_{i(step)}$ min.

For *voltage detector*s 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 detector*s 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 detector*s 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 electrode*s with bare live part(s) of the installation.

4.2.1.4 Successive indication

*Voltage detector*s indicating more than one operating voltage shall be so designed and constructed that when the presence of an operating voltage is indicated, all *indicator*s 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 detector*s covered by this standard is to provide clear evidence of the presence or absence of the operating voltage. In case of *interference voltage*s on the part to be tested, the indication may be different according to the internal impedance of *voltage detector*s.

*Voltage detector*s 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 iInstructions 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 detector*s 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 °C	Highest temperature with r.h.> 95 % °C	Highest absolute humidity $g \cdot m^{-3}$
(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 detector*s 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 detector*s 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 *lead*s. 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 element*s 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 condition*s,
– 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 hydroscopic 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*.

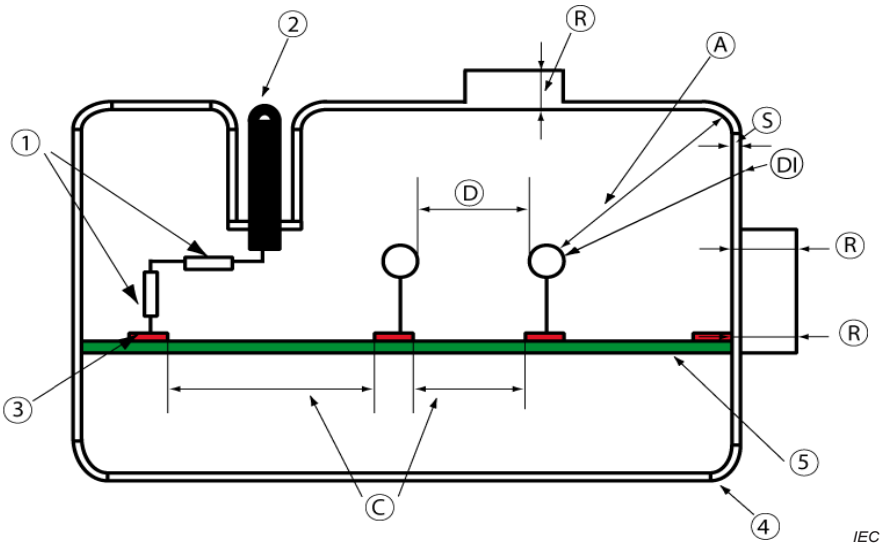


Figure 1a – Illustration of the electrical insulation of an indicator casing

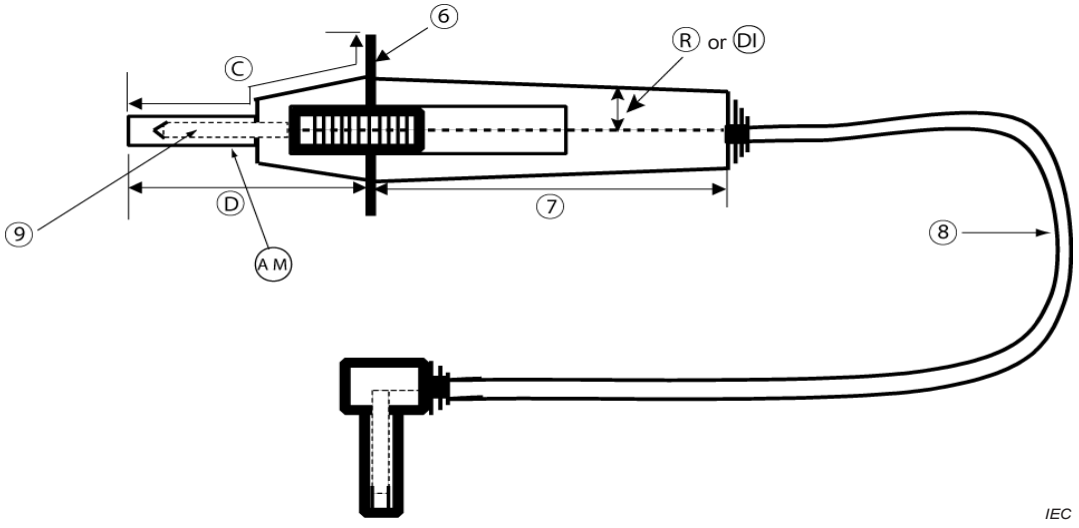


Figure 1b – Illustration of the electrical insulation of a probe with a detachable lead

Key

1	*protective impedance* made of two current limiting elements or one high integrity element = R	9	*contact electrode*
2	accessible conductive part	A	*basic insulation*
3	copper track energized with the working voltage	AM	*basic insulation* 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 *probe* body	D	clearance distance (in air)
8	*lead*	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 detector*s 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 detector*s. 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 detector*s.

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 [a]	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*".

[a] 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 detector*s shall withstand the electrical stresses likely to occur when applied to the installations for which they have been designed. These electrical stresses include:

– *transient overvoltage*s,

– *temporary overvoltage*s.

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

*Temporary overvoltage*s 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 *lead*s shall be rated for the maximum voltage and current expected during normal use of the *voltage detector*.

4.3.7 Probes

The *probe*s 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 *probe*s 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

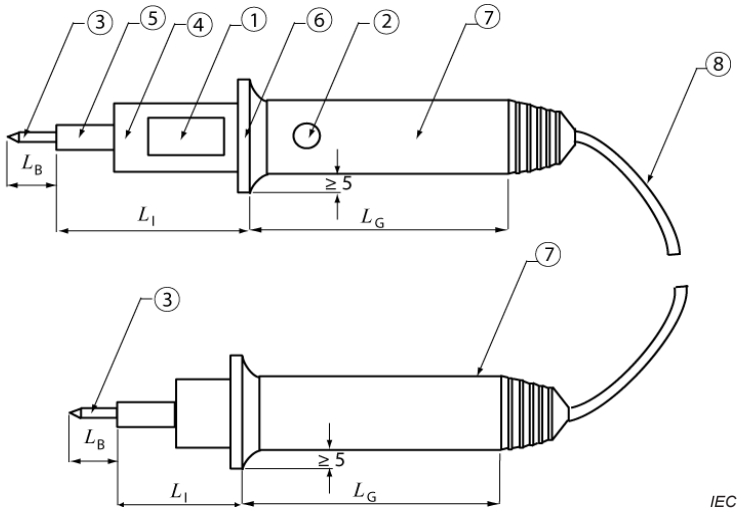


Figure 2a – Example of a voltage detector with the indicator integrated in a probe

Dimensions in millimetres

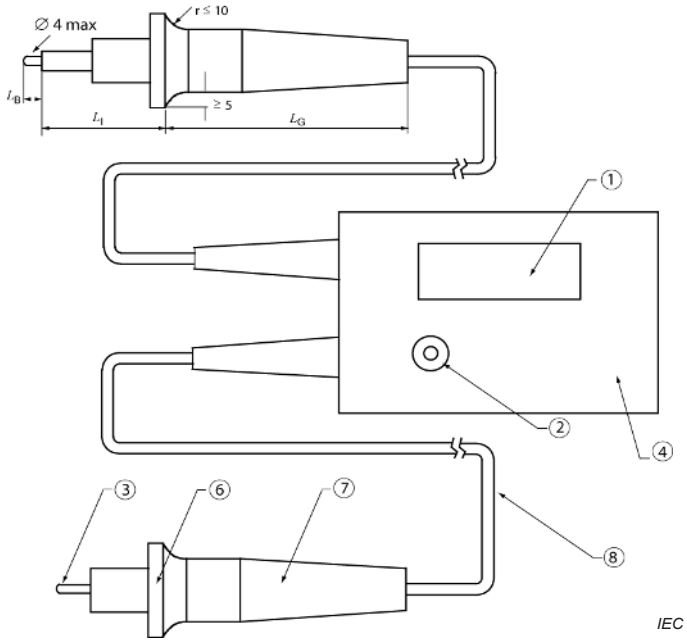


Figure 2b – Example of a voltage detector with the indicator not integrated in a probe

Key

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

Figure 2 – Voltage detector

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

Crocodile clips are not allowed for *voltage detector*s.

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 *lead*s 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 *lead*s.

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

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

The insulated parts of the *contact electrode*s 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 *lead*s shall withstand specific normal service stresses.

Flexible single core *lead*s shall have a conductor cross-sectional area of not less than 0,75 mm^2. Multi-core *lead*s shall have a total conductor cross-section of at least 1,0 mm^2.

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 *lead*s, 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 *lead*s, 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 frequencie(s) 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 detector*s 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 detector*s 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 detector*s designed only for a.c., the presence of d.c. voltage exceeding the ELV limit shall be indicated.

For *voltage detector*s 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.

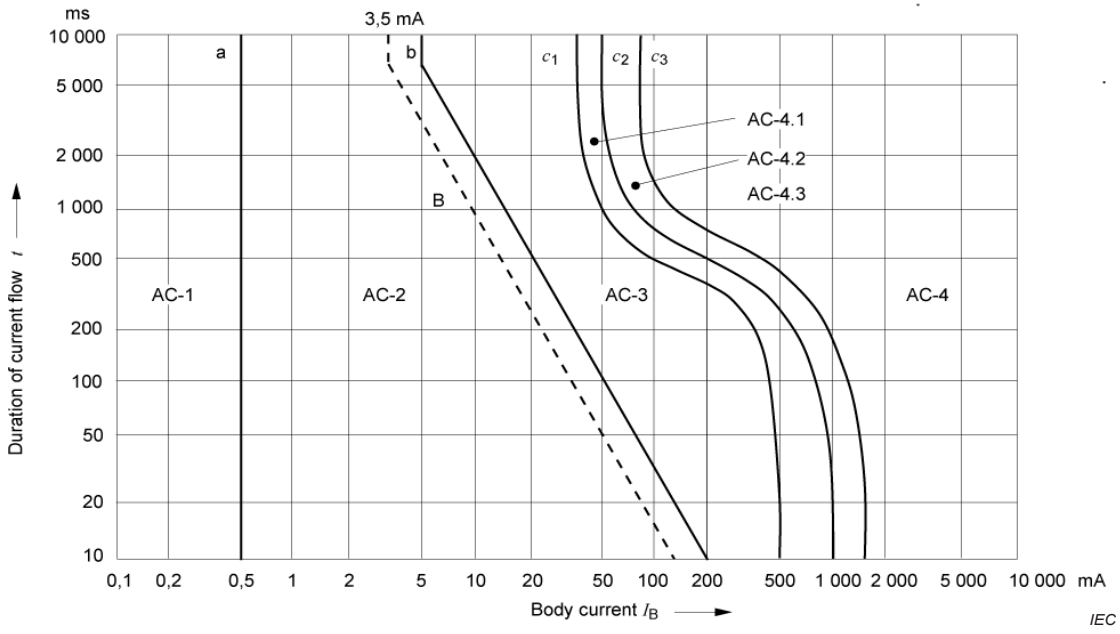


Figure 3 – Maximum rms a.c. current to earth in case of misuse

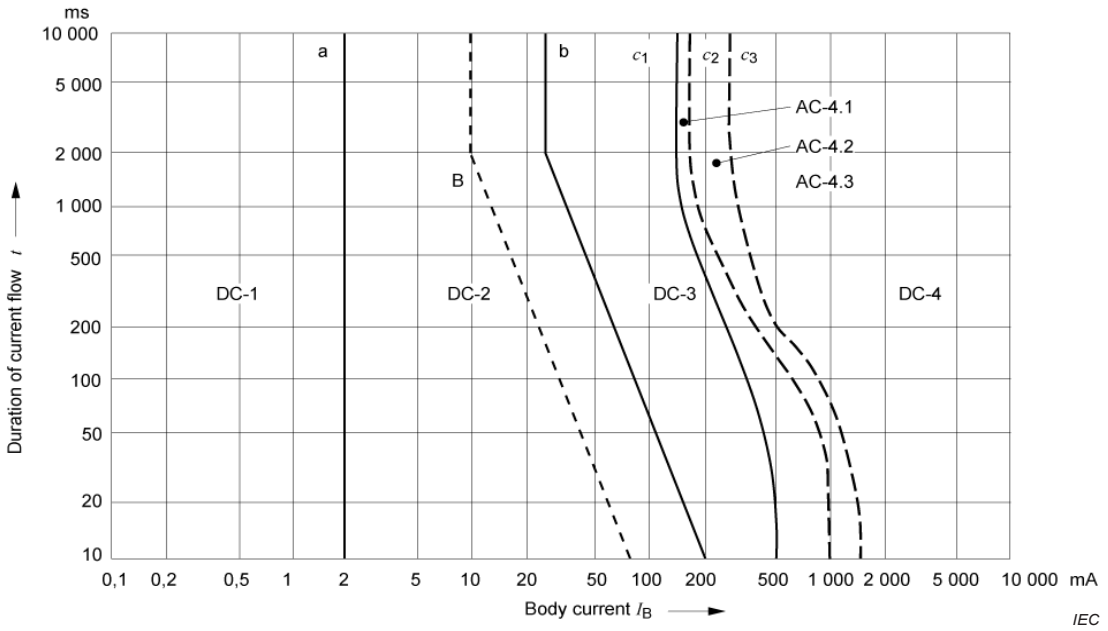


Figure 4 – Maximum d.c. current to earth in case of misuse

In case of misuse, *voltage detector*s that may have currents to earth exceeding the values given above shall have additional protective means for avoiding hazardous inadvertent access to the *contact electrode*s. 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 electrode*s (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 electrode*s, 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 detector*s 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 detector*s.

Three additional *voltage detector*s 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 detector*s. If, again, any of the *voltage detector*s 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 condition*s 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 ± 5) °C and at a relative humidity between 30 % and 75 %.
– The *voltage detector*s for type tests shall be stored at an ambient temperature of (23 ± 5) °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.): ±3 %
  - test voltage (impulse): ±5 %
  - current: ±1,5 %
  - frequency: ±0,2 %
  - temperature: ±2 K
  - relative humidity: ±3 %
  - time of impulse voltage: ±20 %
    time (test duration) ±1 %
– For dimensions of the *voltage detector*, a tolerance of ± 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 detector*s 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 electrode*s 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 detector*s with an *internal energy source*, the source shall be removed before the test.

The *contact electrode*s 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 $^{0}_{-5}$ %.

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

For *voltage detector*s 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 detector*s (a.c. and/or d.c.) under a.c. condition only.

The *contact electrode*s 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 $^{0}_{-5}$ %. 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).

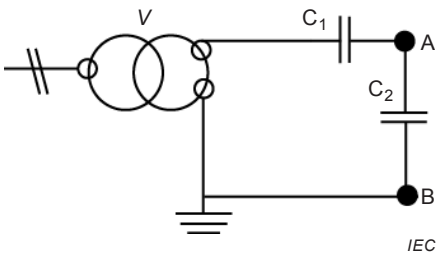
5.3.1.4.3 Performance of voltage detector claiming to be able to distinguish an operating voltage from an interference voltage

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^2 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_1	capacitor of 1 500 pF representing the cacacitive coupling between the two power cables
C_2	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 $^{0}_{-5}$ %.

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 mat 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 detector*s 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.

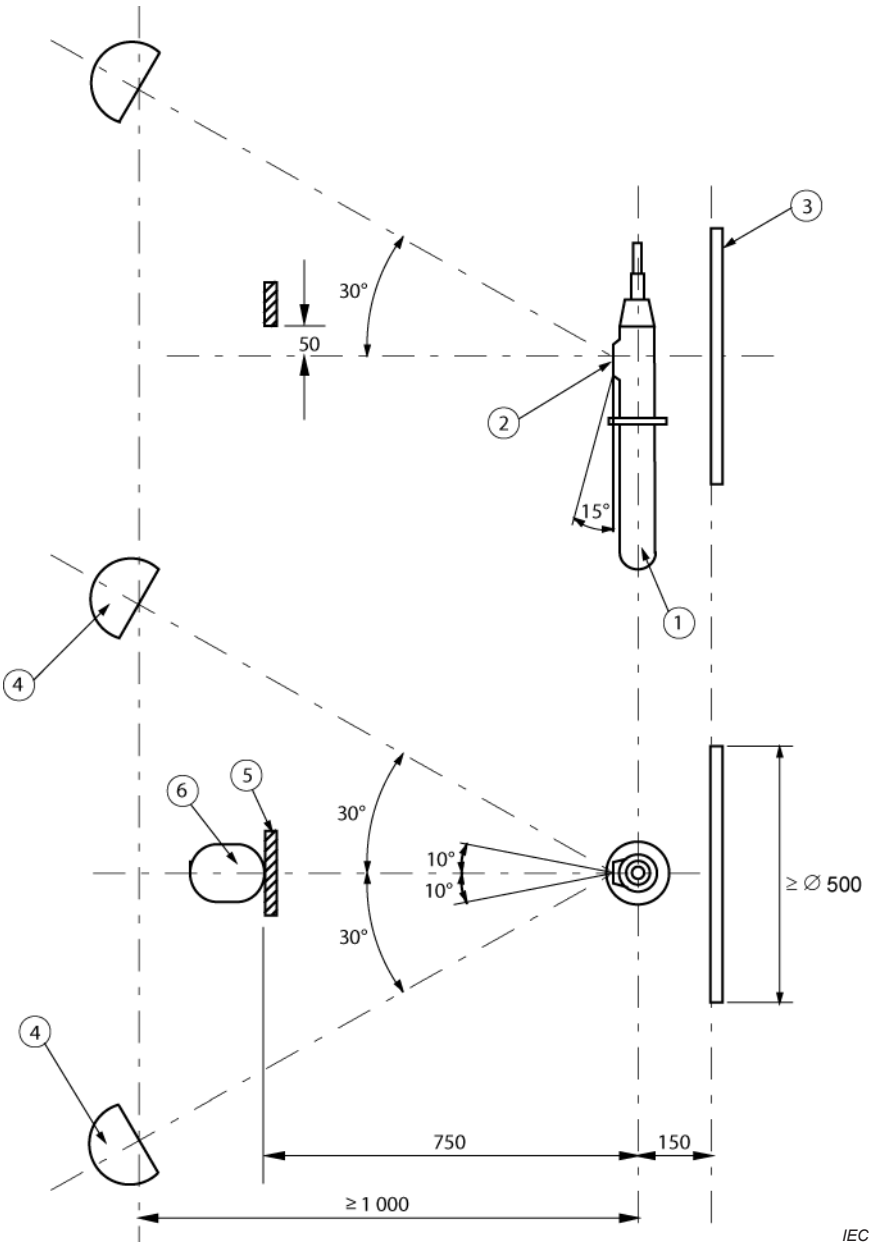
The *voltage detector* shall be rotated from the original vertical position to an angle of 15° and back to the original position, the display of the *indicator* being turned by rotation around the longitudinal axis of the detector by an angle of 10° to the right and to the left in order to identify the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



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 $^{0}_{-5}$ %.

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.

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 co-ordinates 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

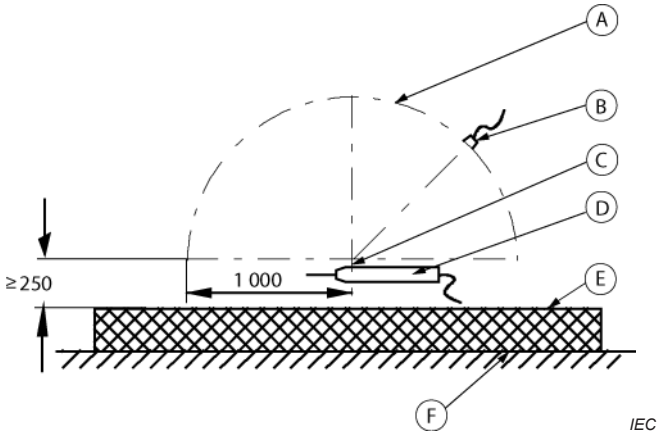
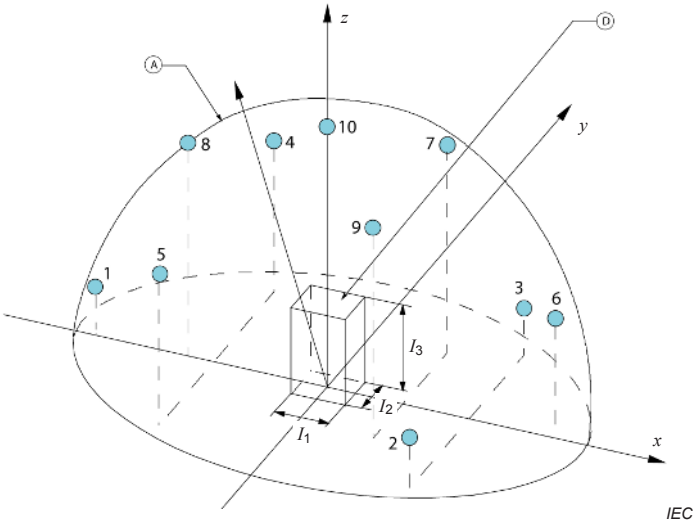


Figure 7a – Positioning of the voltage detector in the test set-up



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

The test shall be considered as passed if the values of the A-weighted time-averaged sound pressure levels, both for point 10 and for the average obtained for point 1 to 10, are equal to or exceed:

– 58,5 dB for continuous sound;
– 55,5 dB for intermittent sound.

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

The alternative test consists of comparing the perceptibility of the audible 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 5.3.3.1 (reference *voltage detector*).

5.3.4 Temperature and humidity dependence of the indication

5.3.4.1 Verification of the threshold voltage and of the ELV indication

5.3.4.1.1 Type test

The *voltage detector* shall be checked for its *threshold voltage*(s) according to 5.3.1.1.2 and for the ELV indication according to 5.3.1.2.1 for each of the three following climatic conditions of its climatic category.

Table 4 – Parameters to be observed to check the climatic dependence

Climatic category	Temperature °C	Relative humidity %	Absolute humidity g/m^3
N	–15	–	–
	+31	95	30
	+45	45	30
S	–30	–	–
	+31	95	30
	+60	24	30

The *voltage detector* shall be placed in a climatic chamber adjusted to each set of climatic test conditions of Table 4 and shall be kept in the test chamber for 2 h before performing the tests. The *voltage detector* shall be kept in the climatic chamber during the test.

The test shall be considered as passed if for the three climatic conditions of the climatic category of the *voltage detector* the sanctions of 5.3.1.1.2 and 5.3.1.2.1 are fulfilled.

For category S, when performing the test at the lower temperature, any *internal energy source* may be removed from the *voltage detector* during the cool down and replaced in the *voltage detector* just before performing the test under voltage.

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

After completing the production phase, it is not practical to perform tests under climatic conditions 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 temperature and humidity dependence.

5.3.4.2 Verification of the perceptibility of the visual and audible indications

5.3.4.2.1 Type test

This test may be combined with 5.3.4.1.1.

The test for *clear perceptibility* of the visual indication consists of comparing the perceptibility of the visual indication of the *voltage detector* within the climatic chamber to the one of a *voltage detector* tested according to 5.3.2.1 but kept at the ambient climatic conditions. The test shall be considered as passed if both perceptibilities are similar.

The test for perceptibility of the audible indication shall be considered as passed if audible signals (if any) are perceived while the *voltage detector* remains within the climatic chamber.

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

After completing the production phase, it is not practical to perform tests under climatic conditions 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 climatic performance.

5.3.5 Frequency dependency for a.c. voltage detector

5.3.5.1 Verification of the threshold voltage and of the ELV indication

5.3.5.1.1 Type test

For an a.c. *voltage detector*, the tests according to 5.3.1.1.2 and 5.3.1.2.1 shall be repeated at 97 % and 103 % of each nominal frequency of the *voltage detector* or, in case of a frequency range, at 97 % of the minimum nominal frequency and 103 % of the maximum nominal frequency of the frequency range.

The tests shall be considered as passed if the sanctions of 5.3.1.1.2 and of 5.3.1.2.1 are fulfilled.

5.3.5.1.2 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 frequency performance.

5.3.5.2 Verification of the perceptibility of the visual and audible indications

5.3.5.2.1 Type test

The tests according to 5.3.2.1 and 5.3.3.1 shall be fulfilled at 97 % and 103 % of each nominal frequency of the *voltage detector* or, in case of a frequency range, at 97 % of the minimum nominal frequency and 103 % of the maximum nominal frequency of the frequency range.

This test may be combined with 5.3.2.1 and 5.3.3.1.

5.3.5.2.2 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 frequency performance.

5.3.6 Ripple dependency for d.c. voltage detector

5.3.6.1 Verification of the threshold voltage and of the ELV indication

5.3.6.1.1 Type test

For a d.c. *voltage detector*, the tests according to 5.3.1.1.2 and 5.3.1.2.1 shall be repeated with a peak ripple factor of 4 %.

The tests shall be considered as passed if the sanctions of 5.3.1.1.2 and of 5.3.1.2.1 are fulfilled.

5.3.6.1.2 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 affect ripple performance.

5.3.6.2 Verification of the perceptibility of the visual and audible indications

5.3.6.2.1 Type test

The tests according to 5.3.2.1 and 5.3.3.1 shall be fulfilled with a peak ripple factor of 4 %. This test may be combined with 5.3.6.1.1.

5.3.6.2.2 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 ripple performance.

5.3.7 Response time

5.3.7.1 Type test

The test voltage shall be the *threshold voltage* value corresponding to each *indicating voltage* of the *voltage detector* plus 10 %.

The test voltage shall be applied ON, then OFF and ON 20 times. The duration of the ON and OFF periods shall be adjusted to 500 ms.

The test shall be considered as passed if each visual and audible signal (if any) is seen and heard as a rhythmical indication having a minimum frequency of 1 Hz. The first signal(s) shall appear during the first cycle.

The test shall be repeated with a period of 1 s in case of *voltage detector* declared as having a *response time* above 500 ms.

The test shall be considered as passed if each visual and audible signal (if any) is seen and heard as a rhythmical indication having a minimum frequency of 1/2 Hz. The first signal(s) shall appear during the first cycle.

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

The alternative means consists in performing the type test of 5.3.7.1 with a reduced number of cycles, provided that the manufacturer shall prove that he has followed the same documented assembly procedure as per the type tested device and he has documented components that could affect the *response time*.

5.3.8 Power source dependability

The *internal energy source* of the *voltage detector* (if any) 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.

A test voltage of $1{,}1 U_{\text{n max.}}$ shall be applied five times to the *voltage detector*.

The test shall be considered as passed if the *voltage detector* displays the presence of $U_{\text{n max.}}$ at each time.

5.3.9 Testing element

5.3.9.1 Voltage detector having an internal energy source

When connecting the two *contact electrode*s together, the *testing element* shall be activated according to the instructions for use.

A visual and/or audible signal shall appear according to the instructions for use. The *testing element* shall be activated three times, and a signal for readiness shall appear each time.

Except when the *testing element* is solely actuated by connecting the *contact electrode*s together, the test shall be repeated three times with the *contact electrode*s not connected together. Then the signal for non-readiness shall appear each time.

The electric circuit (and the flow chart if a software is used) shall be checked to verify that all circuits are tested, except those mentioned in the instructions for use.

5.3.9.2 Voltage detector without an internal energy source

It shall be checked that the manufacturer makes available a built-in or separate *testing element*. In all cases the *testing element*s shall be tested in accordance with 5.3.9.1 (apart from the energy source checking).

5.3.10 Time rating

5.3.10.1 Type test

The test shall be made at 1,2 times the maximum a.c. (or/and d.c.) nominal voltage of the *voltage detector* during the *time rating* t_{r} declared by the manufacturer and under the most severe operating mode (e.g. switching of a temporary load).

The test shall be considered as passed if the display of all the *indicating voltage*(s) and of the ELV is uninterrupted for all the test period.

5.3.10.2 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 *time rating* performance.

5.4 Tests for electrical requirements

5.4.1 Tests on the insulation

5.4.1.1 Insulating material

It shall be checked by *inspection* that the non-metallic enclosures that provide protection against hazard from electric shock have a material CTI rating of at least 400 according to IEC 60112.

It shall be checked by *inspection* that the design of the accessible conductive parts and of the accessible surface of parts of insulating material fulfil the requirements of 4.3.1.

5.4.1.2 Test on the complete equipment

5.4.1.2.1 General

The *voltage detector* shall be preconditioned according to 6.1.3.2 and Table F.6 of IEC 60664-1:2007 for damp heat conditions (93 % RH, 40 °C during 96 hours-one cycle).

An electrically conductive covering shall be placed around all parts of the *voltage detector*. This covering shall be placed so near to the non-insulated part of the *contact electrode*s that the creepage distance to each of them is 20 mm.

One pole of the test voltage source shall be connected with the *contact electrode*s of the *voltage detector* gathered together and the other pole with the conductive covering.

The tests on the insulation of the complete equipment shall be carried out within 10 min after the preconditioning.

5.4.1.2.2 Impulse withstand test

The impulse withstand voltage levels shall be selected in accordance with Table 2 or Table 3.

According to 6.1.3.3.1 of IEC 60664-1, the impulse test shall be conducted for 5 impulses of each polarity with an interval of at least 1 s between impulses. The wave shape of each impulse shall be recorded.

For areas designed with *basic insulation* (e.g. non-accessible parts) the impulse test for *basic insulation* is first performed, then the conductive covering is removed from areas identified as *basic insulation* and the test is repeated with values of Table 3. The test sequence for basic or reinforced insulation may be changed.

The test shall be considered as passed if no puncture or partial breakdown of solid insulation occurs. The serviceability of the *voltage detector* may be impaired.

5.4.1.2.3 AC voltage test

5.4.1.2.3.1 Type test

For *basic insulation*, supplementary and reinforced insulation, the test voltage shall be selected in accordance with Table 5.

The voltage shall be raised uniformly from 0 V to the test value within not more than 5 s and held at that value for 3 min.

Table 5 – AC voltage values for test on the complete equipment

Voltage line to neutral derived from nominal voltages a.c. or d.c. up to and including V	**AC voltage for basic and supplementary solid insulation** V (rms)	**AC voltage for reinforced solid insulation** V (rms)
50	1 250	2 500
100	1 300	2 600
150	1 350	2 700
300	1 500	3 000
600	1 800	3 600
1 000	2 200	4 400
NOTE 1 According to 6.1.3.4.1 of IEC 60664-1:2007, the basic and supplementary insulation test values are based on short-term *temporary overvoltage* defined as U_n + 1 200 V, where U_n is the nominal line to neutral voltage of the neutral-earthed supply system. NOTE 2 According to 6.1.3.4.1 of IEC 60664-1:2007, for reinforced insulation, the test voltage is twice the voltage for *basic insulation*.		

The test shall be considered as passed if no breakdown of solid insulation occurs. The serviceability of the *voltage detector* may be impaired.

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

The test of 5.4.1.2.3.1 shall be performed but without conditioning and for 5 s.

5.4.2 Protection against electric shocks

5.4.2.1 Type test

The determination of accessible parts of the *voltage detector* shall be made in accordance with 6.2 of IEC 61010-1.

The *voltage detector* shall be wetted according to the test procedure of IEC 60529 corresponding to the protection degree declared by the manufacturer (see 4.4.3 and 4.5.2). Immediately after wetting, the *voltage detector* shall be thoroughly dried.

An electrically conductive covering shall be placed around all the accessible parts behind the hand guard in such a way to be in close contact with them. The position of the conductive covering shall not *lead* to flashover or breakdown of the test set-up.

One pole of the test voltage source shall be connected with the *contact electrode*s of the *voltage detector* gathered together, and the other pole shall be connected to the conductive covering through an ammeter connected in series.

The leakage current shall be measured continuously during the application of the test voltage.

The voltage to be considered shall be either:

– 1,2 times the maximum a.c. nominal voltage of the *voltage detector* divided by $\sqrt{3}$, or

– 1,2 times the maximum d.c. nominal voltage of the *voltage detector*.

The test voltage shall be applied for at least 5 s.

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

The test shall be considered as passed, if no flashover or breakdown occurs and if the leakage current values remain within the limits specified in 4.3.2.

5.4.2.2 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 protection against electric shocks.

5.4.3 Current limiting elements

It shall be verified by *inspection* of the circuit diagram the presence of impedance to limit the current flowing through the part of the electric circuit involved in the detection function of the *voltage detector*.

It shall be verified by *inspection* of the circuit diagram the absence of fuses. If fuses are present it shall be verified they are used for the continuity check function only.

5.4.4 Minimum clearance and creepage distances

The clearance and creepage distances shall be verified by *inspection* and measurement according to 4.3.4. The methods to measure creepage and clearance distances are given in 6.2 of IEC 60664-1:2007.

The current limiting element and current limiting circuit shall fulfil the requirements of *basic insulation* for creepage and clearance.

When switches for temporary loading are used in the detecting circuit, creepage and clearance of the contact separation shall fulfil the requirements for *basic insulation*.

Examples of clearance and creepage distances to be considered are illustrated in Figure 1.

5.4.5 Protection against electrical stresses

5.4.5.1 Protection against transient overvoltages

A composite test (combination of an impulse voltage test associated with an impulse current test) shall be performed on the *voltage detector* in order to check the performance of its voltage limiting devices.

A hybrid impulse generator shall generate a standard impulse in accordance with IEC 61180-1 (the open-circuit output voltage has a virtual front time of 1,2 μs and a virtual time to half-value of 50 μs; the short-circuit output current has a virtual front time of 8 μs and a virtual time to half-value of 20 μs). The virtual impulse generator impedance (ratio between the peak open-circuit output voltage and peak short-circuit current) shall be 2 Ω.

Ten impulses of each polarity, spaced up to 1 min apart, shall be applied between the *contact electrode*s of the *voltage detector*. The peak value of the open-circuit output voltage of the impulse generator shall be according to Table 2 for the corresponding rated voltage of the *voltage detector* and its overvoltage category.

The test shall be considered as passed if after the application of the 20 impulses, the serviceability of the *voltage detector* including the ELV limit indication is not impaired.

5.4.5.2 Protection against temporary overvoltages

With reference to IEC 61180-1 and IEC 61180-2, a temporary short term a.c. overvoltage test shall be performed. According to IEC 60664-1, the test voltage shall be the phase to earth voltage corresponding to the maximum nominal voltage of the *voltage detector* + 1 200 V and shall be applied during 1 s between the *contact electrode*s. The power source for the test shall have an output of not less than 5 kVA. For *voltage detector*s with more than one nominal voltage or with a nominal voltage range(s), the phase to earth voltage shall be derived from the highest nominal voltage.

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

The test shall be considered as passed if there is no phenomenon which could cause a danger to the user (e.g. electric shock, explosion, flames outside).

The serviceability of the *voltage detector* may be impaired.

5.4.5.3 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 against electrical stresses.

5.4.6 Lead(s)

The adequacy of the voltage rating of the *lead*s is covered by the tests of 5.4.1.

5.4.7 Probe(s)

The adequacy of the voltage rating of the *probe*s is covered by the tests of 5.4.1. Additionally the double insulation or reinforced insulation characteristics of the *probe* shall be verified by visual verification and measurement (see Figure 1b).

5.4.8 Connector(s)

The adequacy of the voltage rating of the connectors is covered by the tests of 5.4.1. Additionally it shall be checked, in accordance with 6.2 of IEC 61010-1 that in unmated position (if any) *hazardous live* parts of the connector are not accessible in accordance with elements c)i) of 6.4.1 of IEC 61010-031:2002.

5.4.9 Switches for temporary loading (if any)

5.4.9.1 Type test

The switches for temporary loading shall be submitted to a current and voltage equal to the values determined by the circuit incorporated in the *voltage detector*.

1 000 switch operations shall be performed at

– 1,2 time the maximum a.c. nominal voltage of the *voltage detector*, or
– 1,2 time the maximum d.c. nominal voltage of the *voltage detector*.

For an a.c./d.c. *voltage detector*, the test shall be performed for each type of voltage but with 500 operations each.

The operation rate shall not exceed 35 operations per minute.

The test shall be considered as passed if the measured load- and no-load currents do not vary by more than 10 % between the beginning and the end of the test. The current needs not be measured after each operation.

5.4.9.2 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 reliability of the switches used for temporary loading.

5.5 Tests for mechanical requirements

5.5.1 Design

The design of the *voltage detector* shall be verified by *inspection* according to 4.4.1.

5.5.2 Dimensions, construction

The construction and dimensions of the *voltage detector* shall be verified by *inspection* according to 4.4.2.

5.5.3 Degree of protection provided by enclosures

5.5.3.1 Type test

The *voltage detector* shall be tested according to IEC 60529 for the degree of protection declared by the manufacturer (see 4.4.3 and 4.5.2).

The test shall be considered as passed if the serviceability of the *voltage detector* including the ELV limit indication is not impaired even if dust or water is found. Limitations given by IEC 60529 shall be considered.

5.5.3.2 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 degree of protection provided by the enclosures.

5.5.4 Vibration resistance

5.5.4.1 Type test

The test method shall be in accordance with IEC 60068-2-6.

The *voltage detector* shall be fastened to the vibrator by rigid intermediate parts which shall not affect the test results. The *voltage detector* shall be submitted to sinusoidal rectilinear vibrations in three rectangular perpendicular directions, one of which corresponds to the long axis of the *voltage detector*. The sweep (run of the specified frequency range once in each direction) shall be continuous and the sweeping rate shall be of approximately 1 octave/min. The frequency range shall be from 10 Hz to 150 Hz.

The amplitude and acceleration shall be as follows:

– 0,15 mm peak value between 10 Hz and 58 Hz;
– 19,6 m/s^2 (2 g) peak value between 58 Hz and 150 Hz.

The duration of tests shall be 2 h in each direction.

The test shall be considered as passed if the serviceability of the *voltage detector* is not impaired and the *voltage detector* shows no changes of its safety for further use.

5.5.4.2 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 vibration resistance.

5.5.5 Drop resistance

5.5.5.1 Type test

Prior to the following mechanical drop test, the *voltage detector* shall be placed in a room at the lower temperature of its climatic category for at least 2 h. The test shall be carried out within 3 min after the withdrawal of the *voltage detector* from the climatic room.

The test shall be performed in accordance with free-fall-procedure 1 of IEC 60068-2-31 with the following parameters:

– the test surface shall be concrete or steel. It shall be smooth, hard, and rigid;
– the height of fall shall be not less than 1 m;
– the *voltage detector* shall be dropped from horizontal and vertical rest positions. For the vertical position, the *contact electrode*s shall be downward;
– the number of falls shall be one per position.

The test shall be considered as passed if the serviceability of the *voltage detector* is not impaired and the *voltage detector* shows no changes of its safety for further use even if the *contact electrode*s are bent, but not destroyed.

5.5.5.2 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 drop resistance.

5.5.6 Shock resistance

5.5.6.1 Type test

Prior to the following mechanical shock test, the *voltage detector* shall be placed in a room at the lower temperature of its climatic category for at least 2 h. The test shall be carried out within 3 min after the withdrawal of the *voltage detector* from the climatic room.

The *voltage detector* shall be held firmly against a rigid support and tested with the pendulum hammer specified in Clause 4 of IEC 60068-2-75:1997.

The impact locations shall be identified as all external parts which are accessible in normal use and which would be likely to cause a hazard if broken.

Three blows with energy of 1 J shall be applied to each identified impact location.

The test shall be considered as passed if the serviceability of the *voltage detector* is not impaired and the *voltage detector* shows no changes of its safety for further use.

5.5.6.2 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 shock resistance.

5.5.7 Possible disassembling

It shall be checked by *inspection* that the requirements of 4.4.7 are fulfilled.

5.5.8 Surface temperature

5.5.8.1 Type test

The *voltage detector* shall be placed in a test room with no forced air convection. The *voltage detector* shall be thermally isolated from any surface acting as a heat sink (ex: metallic plate).

For *normal condition*, the *voltage detector* shall be submitted to 10 sequences of the specified *time rating* and *recovery time* for the most severe voltage in normal operation and under the maximum ambient temperature of its climatic category. For *single fault condition*, the *voltage detector* shall be submitted to the most severe voltage during the *time rating* declared by the manufacturer.

Handling and working conditions shall be in accordance with the manufacturer's instructions for use. The temperature shall be measured when steady state has been reached. The temperature shall always be measured, immediately after disconnection, at the hottest point on all surfaces located behind the hand guards.

The hottest point may be located and its temperature estimated using an infrared measuring device. For recording the hottest surface temperature, an appropriate thermocouple sensor (type and size) shall be used. In case the estimated temperature is more than 10 °C below the maximum permissible surface temperature, the record can be omitted.

The test shall be considered as passed if no points exceed the temperature limits given in Table 6.

Table 6 – Maximum permissible surface temperatures

	Maximum temperature of surfaces °C	
	Climatic category N	**Climatic category S**
Metallic surfaces in *normal condition*	60	75
Non-metallic surfaces in *normal condition*	75	90
All surfaces in *single fault condition*	110	125

NOTE The maximum temperature can be determined by measuring the temperature rise under reference temperature test conditions and adding this rise to 45 °C for *voltage detector*s of category N or 60 °C for *voltage detector*s of category S.

5.5.8.2 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 heating of the easily touched surfaces.

5.5.9 Heat resistance

5.5.9.1 Type test

Insulating parts of the *probe*s and enclosures adjacent to points specially exposed to thermal stress, excluding *lead*s and soft enclosures, shall fulfil the ball pressure test according to IEC 60695-10-2 at a temperature of 80 °C and with the following deviation.

When the radius of curvature at the test point is ≤10 mm, a rod with a diameter of 4 mm and a length of 30 mm shall be used instead of the standard ball, but with the same load as specified in 4.1 of IEC 60695-10-2:2003. The rod shall be applied at right angles to the test surface.

5.5.9.2 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 material(s) that could affect the heat resistance of the enclosures.

5.5.10 Probes

5.5.10.1 Design and dimensions

The design and dimensions required by 4.4.2 (see Figure 2) shall be verified by visual verification and measurement.

5.5.10.2 Mechanical tests

Resistance to vibration, drop, shock, and resistance to heat for *probe*s (which are considered as a part of the *voltage detector*), are respectively covered by 5.5.4, 5.5.5, 5.5.6 and 5.5.9.

5.5.10.3 Close adhesion of insulation of the insulated part of the contact electrode (when provided)

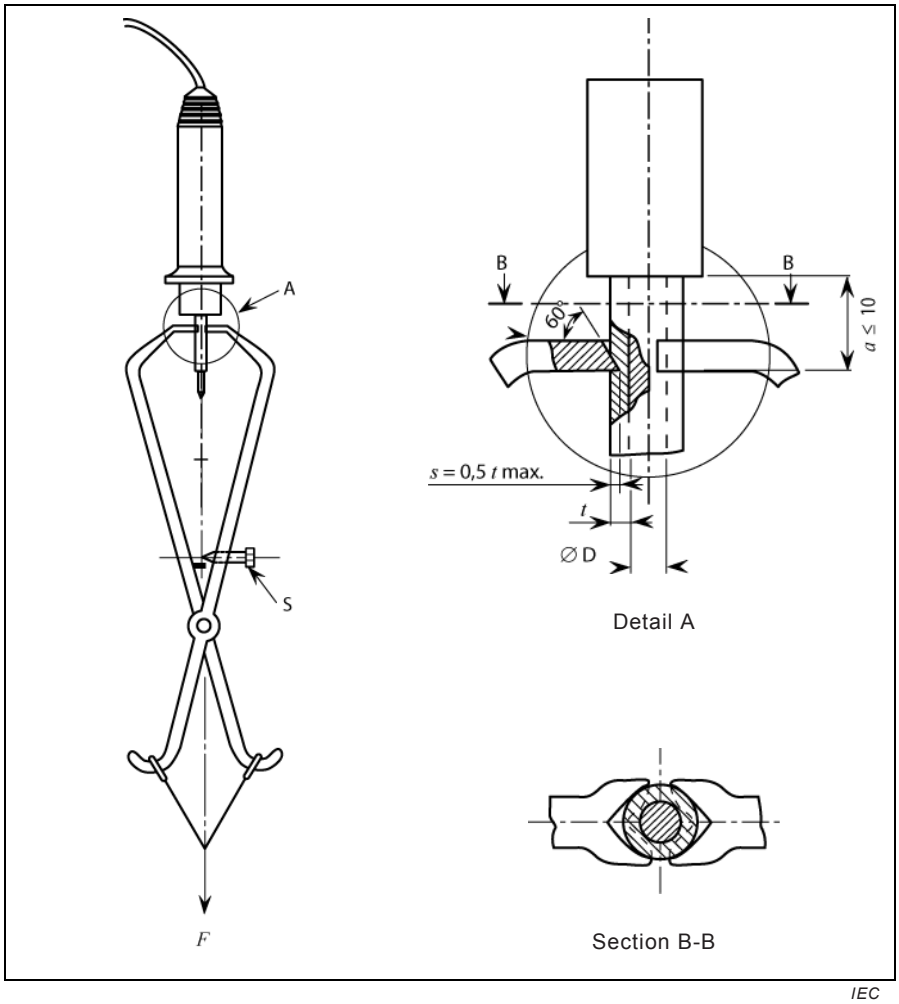
5.5.10.3.1 Type test

This test shall be carried out with a test apparatus according to Figure 8. The penetration depth s of the cutting edges of the test apparatus shall be as small as possible and shall not be greater than half the thickness t of the insulating covering. Distance a between the outlet point of the *contact electrode* from the enclosure (or the end of the shroud) and the engaging part of the cutting edges shall not be more than 10 mm.

The force F (measured in N) shall be 35 times the diameter (measured in millimetres) of the non-insulated part of the *contact electrode*. The force shall be exerted for 1 min in the axial direction.

The test shall be considered as passed if the insulation covering has not peeled from the enclosure or from the *contact electrode*.

Dimensions in millimetres



Key

S adjusting device

Figure 8 – Test set-up for close adhesion of insulation of the insulated part of the contact electrode

5.5.10.3.2 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 close adhesion of the insulation.

5.5.11 Lead(s)

5.5.11.1 Type test

5.5.11.1.1 Visual and dimensional check

It shall be checked by *inspection* and measurement that the dimensional requirements of 4.4.11 are fulfilled.

In the case of detachable *lead*s, it shall be checked visually that the connection to the *indicator* consists of a female connector in accordance with 4.4.11.

5.5.11.1.2 Tensile test (for detachable *lead* only)

Each detachable *lead* shall be connected for its intended purpose in such a position that no bending force is applied to the *lead* or the connector when the test force is applied.

A tensile force up to 10 N shall be gradually applied to the free end of the *lead*, without jerking, and shall be maintained for 1 min.

The test shall be considered as passed if the *lead* has not been displaced from its connecting point by more than 2 mm.

5.5.11.1.3 Pull relief test

The *probe* or the connector shall be fastened in a position such that the *lead* hangs vertically downwards. The electrical conductor of the *lead* shall be detached from the connecting point in the *probe* or the connector in a way that the pull relief depends only on the core insulation. The *lead* shall be marked with a reference line so that it can be observed whether it has moved during the test.

The free end of the *lead* shall be loaded and unloaded 50 times with 1 period/s with a force of 60 N.

The test shall be considered as passed if the reference line on the *lead* has moved by less than 2 mm.

5.5.11.1.4 Lead attachment – Pull test

The tests according to 6.7.4.1 of IEC 61010-031:2002 apply.

The test shall be considered as passed if the sanctions of 6.7.4 of IEC 61010-031:2002 and IEC 61010-031:2002/AMD1:2008 are fulfilled.

5.5.11.1.5 Flexing/pull test

The tests according to 6.7.4.2 of IEC 61010-031:2002 and IEC 61010-031:2002/AMD1:2008 apply.

The test shall be considered as passed if the sanctions of 6.7.4 of IEC 61010-031:2002 and IEC 61010-031:2002/AMD1:2008 are fulfilled. The socket guard (if any), shall not separate from the body, and the insulation of the *lead* shall show no sign of abrasion or wear.

5.5.11.1.6 Rotational/flexing test

The tests according to 6.7.4.3 of IEC 61010-031:2002 and IEC 61010-031:2002/AMD1:2008 apply.

The test shall be considered as passed if the sanctions of 6.7.4 of IEC 61010-031 and IEC 61010-031:2002/AMD1:2008 are fulfilled.

5.5.11.1.7 Wear test

The wearing of the insulating material of the *lead*s shall be checked by performing the test specified in 6.7.5 of IEC 61010-031:2002 and IEC 61010-031:2002/AMD1:2008.

The test shall be considered as passed if the sanctions of 6.7.4 of IEC 61010-031 and IEC 61010-031:2002/AMD1:2008 are fulfilled.

5.5.11.2 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 mechanical performance of the *lead*.

5.6 Marking

5.6.1 Visual inspection and measurement

5.6.1.1 Type test

The marking required in 4.5 shall be verified by visual *inspection* and measurement.

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

At the production level, it is only needed to check for the presence of all the items of marking by visual *inspection*.

5.6.2 Durability of marking

The durability of marking shall be checked by rubbing successively with a rag soaked in water for at least 1 min then with another rag soaked in isopropanol (CH_3-CH(OH)-CH_3) for another 1 min. It is the employer's duty to ensure that any relevant legislation and any specific safety instructions regarding the use of isopropanol are fully observed

The test shall be considered as passed if the markings remain legible and the letters do not smear.

The surface of the *voltage detector* may change. No sign of loosening shall be present for labels.

Marking produced by an engraving or moulding process shall be deemed to comply without test.

5.7 Instructions for use

5.7.1 Type test

A visual check shall be performed to verify that all the requirements of 4.6 are fulfilled.

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

At the production level, it is only needed to check for the availability of the instructions for use.

5.8 Tests for reasonably foreseeable misuse during live working

5.8.1 AC/DC voltage misuse

*Voltage detector*s designed for a.c. and d.c. voltages shall not be submitted to test.

The *contact electrode*s of the *voltage detector* designed for exclusive use on d.c. shall be connected to an a.c. voltage source. The voltage shall be increased until reaching the a.c. ELV voltage value (50 V).

The *contact electrode*s of the *voltage detector* designed for exclusive use on a.c. shall be connected to a d.c. voltage source. The voltage shall be increased until reaching the d.c. ELV voltage value (120 V).

The test shall be considered as passed if, in both cases, at least, the ELV indication of the *voltage detector* appears.

5.8.2 Maximum current to earth in case of misuse

5.8.2.1 Type test

This test does not apply to *voltage detector*s having additional protective means for avoiding hazardous inadvertent access to the *contact electrode*s as specified in 4.7.2.

For *voltage detector*s without these additional protective means, this test shall be performed unless it can be shown by examination or calculation that the current satisfies the requirement of 4.7.2.

The test equipment shall consist of a voltage source in series with a current recording device, both of them in parallel with a voltmeter.

The *voltage detector* shall be connected to the test equipment and the current shall be measured and shall be recorded during the specified *time rating* while the test voltage is applied to the *voltage detector*.

The test voltage to be considered shall be either:

- the maximum a.c. nominal voltage of the *voltage detector* divided by $\sqrt{3}$, or
- the maximum d.c. nominal voltage of the *voltage detector*.

If based on the design of the *voltage detector* a higher current can be expected for voltages lower than the values above, additional test(s) shall be carried out at the most unfavorable nominal voltage(s) of the voltage range.

For *voltage detector*s with a maximum nominal frequency higher than 60 Hz, the test shall also be carried out at the maximum nominal frequency.

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

The test shall be considered as passed if the requirements of 4.7.2 are fulfilled.

5.8.2.2 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 current to earth in case of misuse.

5.8.3 Misuse in case of mistaking of the voltage of the low voltage network

5.8.3.1 Type test

The test current source shall be so dimensioned that the voltage falls by not more than 10 % at a load of 5 A.

An a.c. and/or d.c. voltage of 1,2 times the maximum nominal voltage of the *voltage detector* but not less than 1 000 V shall be applied to the *voltage detector* for its *time rating*.

The test shall be considered as passed when no phenomenon occurs which could cause a danger to the user (e.g. explosion, flames outside).

The serviceability of the *voltage detector* may be impaired.

5.8.3.2 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 impair the *voltage detector* in case of mistaking of the voltage of the low voltage network.

6 Conformity testing

For leading the conformity testing during the production phase, IEC 61318 shall be used in conjunction with the present standard.

Annex E, issued of a risk analysis on the performance of the *voltage detector*, provides the classification of defects and identifies the associated tests applicable in case of production follow-up.

7 Modifications

Any change of design or material that affects performance of the *voltage detector*s shall require the type tests to be repeated, in whole or in part, as well as a change in the reference literature.

Annex A
(informative)

Differences with IEC 61010 series

NOTE The comparison has been established using IEC 61010-1(2001) and IEC 61010-031:2002 plus IEC 61010-031:2002/AMD1:2008.

A.1 Existing requirements and tests but with different sanctions or pass test criteria

Requirement/test	This standard	IEC 61010-1 and IEC 61010-031
Protection against electric shock	The criterion for admissible limits on accessible parts is the leakage current between an accessible part and a reference to earth (in *normal condition* and in *single fault condition*). The test circuit does not include resistance other than the internal resistance of the ammeter. **In normal condition** The current limit is 0,5 mA r.m.s. or 2 mA d.c whatever the voltage. **In single fault condition** The current limit is 3,5 mA r.m.s. or 10 mA d.c whatever is the voltage. *More severe*	There is a first criterion on voltage and additional criteria on current and energy between an accessible part and a reference to earth (in *normal condition* and in *single fault condition*). *The additional criteria apply only if the voltage criteria is exceeded.* The test circuit includes a resistance of 2 kΩ to simulate the body resistance. A voltage across this resistance is measured. **In normal condition** For voltages below 33 V r.m.s, or 70 V d.c., there is no limit of leakage current. *(with a measuring resistance of 2 kΩ, it corresponds to 16,5 mA r.m.s or 35 mA d.c.)* For voltages above 33 V r.m.s, or 70 V d.c., the current limit is 0,5 mA r.m.s. or 2 mA d.c. **In single fault condition** For voltages below 55 V r.m.s, or 140 V d.c. there is no limit of leakage current. *(with a measuring resistance of 2 kΩ, it corresponds to 27,5 mA r.m.s or 70 mA d.c.)* For voltages above, the current limit is 3,5 mA r.m.s. or 15 mA d.c.
Clearance distances	Tables 2 and 3 clearly specify that the given clearances are minimum values. For reinforced insulation, the minimum clearances 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].”	This clarification is not included in the tables. For reinforced insulation, the values are twice the values for *basic insulation*. *More severe in some cases*

Requirement/test	This standard	IEC 61010-1 and IEC 61010-031
Creepage distances	Table F.4 of IEC 60664-1:2007 clearly specifies that the given creepage distances are minimum values. Creepage distances for basic and supplementary insulation shall be in accordance with Table F.4 of IEC 60664-1:2007 whatever the material is. *More severe*	This clarification is not included in the tables. For glass, ceramics, or other inorganic insulating materials which do not track, creepage distances need not be greater than their associated clearance.
Insulating material – Conditioning of the tested device	96 h without recovery period before electric test *More severe*	48 h with 2 h of recovery.
Insulating material – Testing conditions	Impulse tests (5 impulses of each polarity) and 3 min a.c. test *More severe*	3 cycles a.c.(or three times 10 ms d.c.) or impulse (three of each polarity) and 5 s test
Mechanical resistance of equipment to shock and impact	**Resistance to heat** of 5.5.9 (Out of sequence test) A static rigidity test is always performed at 80 °C on the insulating parts of *probe*s and enclosures. The test procedure is according to IEC 60695-10-2 (20 N with a ball of 5 mm diameter) or other system when the radius of curvature of the test point is smaller than or equal to 10 mm. The maximum permissible deformation is specified in IEC 60695-10-2. **Shock resistance** of 5.5.6 on *voltage detector* and *probe*s **Drop resistance** 5.5.5 One vertical and one horizontal drop of 1 m height minimum on a concrete or steel surface. (Reference to IEC 60068-2-31 conditions). The *voltage detector* (including the *probe*s) is cooled down to the lower rated temperature for at least 2 h and tested within 3 min.	10.5.2 of IEC 61010-1 and 10.2 of IEC 61010-031:2002 **Resistance to heat** The resistance to heat of non-metallic material of the *probe* assembly and enclosure is checked by performing a heat treatment before subjecting the test object to dielectric strength (for the *probe* assembly) test and to relevant mechanical tests. **Static rigidity test** of 8.1.1 of IEC 61010-1 and 8.1 of IEC 61010-031:2002. The test procedure is different (30 N in IEC 61010-1 and 20 N in IEC 61010-031, with a hemispherical end rod of 12 mm diameter). The test sanction is not precise in terms of deformation of the parts. **Impact (shock) tests** of 8.1.2 of IEC 61010-1 **Corner drop test for hand-held equipment** of 8.2.2 of IEC 61010-1. One drop of 1 m height on a hardwood surface. The equipment is cooled down to the lower rated temperature (for a time not specified) and tested within 10 min.
Protection provided by enclosures	To avoid pollution 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 *lead*s that can be disconnected, 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. *More severe*	Protection by enclosures is considered in the marking but no minimum degree is required and the testing conditions are not specified.

Requirement/test	This standard	IEC 61010-1 and IEC 61010-031
Durability of marking	Checked by rubbing with water during 1 min and with isopropanol for an additional 1 min. *May be more severe*.	Checked by rubbing with the specified cleaning agent during 30 s (or if not specified, with isopropanol).

A.2 List of requirements of IEC 61010 series not included in this standard, with rationale

IEC 61010-1		
Requirements	**Subclause**	**Rationale**
ELV limit indication		The debate about the ELV concept is still pending from TC 109; consequently the Advisory Committee on Safety (ACOS) recommends that the ELV values in the current edition (conventional limit of 50 V a.c./120 V d.c.) of IEC 61243-3 be retained.
Voltage levels in *normal condition*	6.3.1 a)	The debate about the ELV concept is still pending from TC 109 (see above).
Levels of capacitive charge or energy in *normal condition*	6.3.1 c)	This concept doesn't pertain to *voltage detector*s.
Voltage levels in *single fault condition*	6.3.2 a)	The debate about the ELV concept is still pending from TC 109 (see above).
Levels of capacitance	6.3.2 c)	This concept doesn't pertain to *voltage detector*s.
Detecting circuits	6.7.4	Replaced by 4.3.5 of this standard and the tests of 5.4.5 of this standard based on IEC 60664-1 requirements. The inputs of the detecting circuits of the *voltage detector* are submitted to transients and *temporary overvoltage*s for simulating the electric stresses encountered in the field.
IEC 61010-031		
Requirements	**(Sub)clause**	**Rationale**
Protection against the spread of fire	9	Consideration of flame and explosion due to a short-circuit is specifically and differently treated through 5.4.5.2 of this standard (Protection against *temporary overvoltage*s) and 5.8.3 of this standard (Misuse in case of mistaking of the voltage of the low voltage network).
Probe tips for category III and IV	13.2	The length of the conductive parts of the *probe* tips may exceed the values of 13.2 of IEC 61010-031:2002 and IEC 61010-031:2002/AMD1:2008. Most of the low voltage boards and panels to be checked are IP2X designed. Such designs require long tip electrodes for being sure that effective contacts are achieved.

A.3 Additional requirements of this standard, related to safety and functional safety of voltage detectors, with rationale

Requirements of this standard	Subclause of this standard	Rationale
Electromagnetic compatibility (EMC)	4.1.3	For functional safety, the *voltage detector* shall not indicate incorrectly because of electromagnetic field interference.
Clear indication of the operating voltage	4.2.1.1	For functional safety, *voltage detectors* shall be marked with their internal impedance and (if relevant) their ability to distinguish an operating voltage from an *interference voltage*
ELV indication	4.2.1.2	For the safety of the live workers, they shall be warned at any time of the presence, on parts under test, of the limit (ELV) values of hazardous touch voltage.
		For the safety of the live workers, *voltage detector*s having the ELV indication powered by *internal energy source* shall provide the ELV limit indication even when the *internal energy source* is exhausted.
Continuous indication	4.2.1.3	For functional safety, for avoiding any incorrect diagnostic on the status of the voltage, *voltage detector* are intended to be used in direct contact and the *voltage detector* should not indicate as “voltage present”, usual values of *interference voltage* and shall not be affected by adjacent live part.
Clear perceptibility	4.2.2	For functional safety, the correct status of the operating voltage shall be indicated and shall be clearly perceptible under normal light and noise conditions
Temperature and humidity dependence of the indication	4.2.3	For functional safety, the *clear indication* and *clear perceptibility* of the operating voltage shall be assured within the temperature and humidity conditions of its climatic category.
Frequency dependency / Ripple dependency	4.2.4 and 4.2.5	For functional safety, the *clear indication* and *clear perceptibility* of the operating voltage, shall not suffered of a frequency shift (a.c.) or of the presence of a ripple factor (d.c.) representative of normal operating conditions of a a.c. or d.c. network.
Response time	4.2.6	For functional safety, the *voltage detector* shall indicate rapidly the status and any change of the status of the operating voltage to not mistake the live worker on the status of the installation.
Power source dependability	4.2.7	For functional safety, when using a *voltage detector* with *internal energy source*, live workers need to rely on the indication to not be affected by a low battery level.
Testing element	4.2.8	For functional safety, live workers need to check the correct functioning of the *voltage detector* before and after use.
Protection against electric stresses	4.3.5	The inputs of the detecting circuit of the *voltage detector* are submitted to transients and *temporary overvoltage*s for simulating the electric stresses encountered in the field.
Resistance to vibration	4.4.4	For safety and functional safety, the whole *voltage detector* (including the *probe*s) shall withstand vibration stresses representative of transportation conditions.
Possible disassembling	4.4.7	For functional safety, for avoiding any change on the setting of the *voltage detector*, the user shall not have access to internal circuitry and setting.
Tensile stress	4.4.11	For the safety of the worker, the detachable *lead* shall not come out of its terminal point under normal working stresses.
Close adhesion of insulation of the insulated part of the *contact electrode* (when provided)	4.4.10	For the safety of the live workers and the safety of the installation, the insulation over the *contact electrode*s shall resist to the cutting force with sharp pieces encountered in the working environment.

Requirements of this standard	Subclause of this standard	Rationale
Pull/relief stress on the *lead* insulation	4.4.11	For functional safety, the insulation of the *lead* shall not elongate too much under tensile stress (elongation of the insulation would apply additional stress on the conductor which could break and open the indicating circuit).
AC/DC voltage misuse	4.7.1	For the safety of the live workers, the *voltage detector*s designed only for d.c or a.c systems shall indicate the ELV limits in case of use on wrong network (d.c.instead a.c or a.c instead d.c.).
Protective means for avoiding inadvertent access to the *contact electrode*s	4.7.2	For the safety of the live workers, *voltage detector*s having a current to earth exceeding safety values shall be equipped of protection means (ex: IP2X arrangement or simultaneous use of two switches).
Misuse in case of mistaking of the voltage of the low voltage network	4.7.3	For the safety of the live workers, the *voltage detector*s shall remain safe in the event of use on low voltage networks exceeding the nominal voltage for which it has been designed.

Annex B
(normative)

Supplementary functions: Phase indication – Rotating field indication – Continuity check

B.1 Terms and definitions

For the purposes of this annex, the following terms and definitions apply.

B.1.1
phase indication
function of a *voltage detector* which indicates the phase of a live system

B.1.2
accessible electrode
single conductive part of a *voltage detector* designed to be touched by the finger of the hand in order to activate a supplementary function (e.g.: phase indication)

B.1.3
rotating field indication
function of a *voltage detector* which indicates the phase sequence of a three phase live system

B.1.4
continuity check
function of a *voltage detector* which determines whether an electrical circuit is continuous

B.2 General requirements for the supplementary functions

B.2.1 Safety and performance of the voltage detector

The supplementary functions covered in this annex shall not impair the performance and the safe functioning of the *voltage detector*.

B.2.2 Indication

Supplementary function(s) shall give a clear visual and/or audible indication.

B.2.3 Indication only in contact with bare part

Supplementary function(s) shall give a *clear indication* only in case of positive contact with a bare live part.

B.2.4 Temperature rise

The design and construction of the supplementary functions shall be such that when used as specified by the manufacturer, the temperature rises fulfil the requirements of 4.4.8.

B.2.5 Instructions for use

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

They shall at least include the explanation of the indication, the maximum *response time* and the normal position of use.

B.3 General tests for the supplementary functions

B.3.1 Safety and performance of the voltage detector

B.3.1.1 Type test

An a.c. and/or d.c. voltage of 1,2 times the maximum nominal voltage of the *voltage detector*, but not less than 1 000 V, shall be applied to the *voltage detector*. The test circuit shall be capable of delivering not less than 5 kVA.

Each supplementary function shall be activated, one at a time while applying the test voltage.

The test shall be considered as passed if the *voltage detector* still indicates (at least ELV) and no phenomenon occurs which could cause a danger to the user (e.g. explosion, flames outside).

B.3.1.2 Alternative means in case of voltage detectors with supplementary function(s) 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 impair the performance and safe functioning of the *voltage detector* in case a supplementary function is being activated.

B.3.2 Indication

The requirement for indication shall be checked by *inspection*. This *inspection* shall verify the nature of the signal (visual and/or audible) when operative conditions of each supplementary function are met.

B.3.3 Indication only in contact with bare part

For each supplementary function, the requirement of B.2.3 shall be checked by performing the tests of 5.3.1.3.1 respective of the operative conditions of each supplementary function.

The test shall be carried out at the maximum nominal voltage declared by the manufacturer.

When only one *contact electrode* is needed for the operation (e.g.: for phase indication), the voltage shall be applied between a resistance of 10 MΩ connected in series with the *contact electrode*, and either the accessible electrode (when available) or a conductive covering placed around the hand held *probe*.

B.3.4 Temperature rise test

For each supplementary function, the requirements of B.2.4 shall be checked by performing the tests of 5.5.8.

B.3.5 Instructions for use

B.3.5.1 Type test

It shall be checked by visual *inspection* that the requirements of B.2.5 are fulfilled.

B.3.5.2 Alternative test in case of voltage detectors with supplementary function(s) having completed the production phase

At the production level, it is only needed to check for the availability of the instructions for use.

B.4 Phase indication with or without the use of accessible electrode

B.4.1 General

This clause of Annex B covers a phase indication method (either capacitive or resistive) requiring that one *contact electrode* of the device make positive contact with an exposed conductor of the component, system or installation under test.

This method alone is unable to confirm that no voltage is present.

B.4.2 Additional requirements

B.4.2.1 Functional requirements

The device shall give a *clear indication* when the conductor to be identified is a phase conductor.

The visual indication (if any) shall be clearly visible to the user in the operating position and under normal light conditions. The audible indication (if any) shall be clearly audible to the user in the operating position and under normal noise conditions.

NOTE While one *contact electrode* is connected to the conductor to be identified, the phase indication circuit is connected electrically to the earth either by the worker touching the *indicator* casing or touching the accessible electrode when provided.

B.4.2.2 Protection against electric shocks (when an accessible electrode is provided)

When a *voltage detector* having a phase indication supplementary function is provided with an accessible electrode for identification of phase conductors, the internal current limiting impedance connected in series with the accessible electrode shall consist of at least two limiting elements or one high integrity element (see Figure 1a).

The accessible electrode is an accessible part of the *voltage detector* according to 6.2 of IEC 61010-1 and is included in the test for electric shock of 5.4.2.1.

B.4.3 Additional tests

B.4.3.1 Clear indication and clear perceptibility

B.4.3.1.1 Type test

The lower value of the nominal voltage declared by the manufacturer (in accordance with its instruction for use) shall be applied between a resistance of 10 MΩ connected in series with the *contact electrode*, and either the accessible electrode (when available) or a conductive covering placed around the hand held *probe*.

The signal for indicating the phase conductor shall appear.

The *clear perceptibility* of the visual indication (if any) shall be checked by performing the test of 5.3.2.1 with an ambient illumination reduced to 350 lx.

The *clear perceptibility* of the audible indication (if any) shall fulfil the test of 5.3.3.1.

B.4.3.1.2 Alternative tests for clear perceptibility in case of voltage detectors with phase indication having completed the production phase

For the *clear perceptibility* of the visual indication (if any), the alternative test consists of comparing the perceptibility of the visual indication of a *voltage detector* with phase indication having completed the production phase to the one of a *voltage detector* with phase indication which has passed successfully the type test according to B.4.3.1.1 (reference *voltage detector* with phase indication).

For the *clear perceptibility* of the audible indication (if any), the alternative test consists of comparing the perceptibility of the audible indication of a *voltage detector* with phase indication having completed the production phase to the one of a *voltage detector* with phase indication which has passed successfully the type test according to B.4.3.1.1 (reference *voltage detector* with phase indication).

B.4.3.2 Protection against electric shocks (when an accessible electrode is provided)

It shall be proved by *inspection* that the internal current limiting impedance fulfil the requirement of the first paragraph of B.4.2.2.

B.5 Rotating field indication

B.5.1 Additional requirements

The *voltage detector* with this supplementary function may require the use of supplementary *probe* and *lead* for connection to a phase or to earth and one crocodile clip. The crocodile clip (if any) shall comply with IEC 61010-031.

The rotating field indication shall comply with IEC 61557-7, with the following deviations:

– Subclause 4.5 of IEC 61557-7:2007 – the *probe*(s) shall have a protective means as described in 4.7.2 each time the current to earth exceeds 3,5 mA r.m.s.

– Subclauses 4.3 and 6.6 of IEC 61557-7:2007 – the duration of the operation shall be limited in accordance with 4.2.9.

B.5.2 Additional tests

B.5.2.1 Type tests

The fulfilment of IEC 61557-7 shall be checked for the nominal voltages (or nominal voltage range) for which the function is designed as declared by the manufacturer considering the deviations mentioned in B.5.1.

Crocodile clips shall be tested according to IEC 61010-031.

B.5.2.2 Additional means in case of voltage detectors with rotating field indication 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 compromise the conformity to IEC 61557-7 with the specified deviations.

B.6 Continuity check

B.6.1 Additional requirements

B.6.1.1 Functional requirements

The *voltage detector* with this supplementary function shall clearly indicate any resistance value in the external part of the circuit below the value R declared by the manufacturer.

The visual indication (if any) shall be clearly visible to the user in the operating position and under normal light conditions. The audible indication (if any) shall be clearly audible to the user in the operating position and under normal noise conditions.

B.6.1.2 Additional marking

A *voltage detector* with a continuity check function shall be marked with the declared value R with a minimum height of letter of 1 mm.

B.6.2 Additional tests

B.6.2.1 Clear indication

The *contact electrode*s of the *voltage detector* shall be connected to a variable resistance whose value is increased steadily from 0 Ω to the value of $2R$ Ω. The value of the resistance at which the change of state of the indication takes place shall be noted.

The value of the resistance shall then be reduced steadily from $2R$ Ω to 0 Ω and once again the value of resistance at which the change of state of the indication takes place shall be noted. A value of R lower than 100 Ω is recommended.

The test shall be considered as passed if the change of state of the indication, when both increasing and decreasing the external resistance, occurs between 1 R, and 1,5 R.

B.6.2.2 Clear perceptibility of the indication

B.6.2.2.1 Type test

The *contact electrode*s of the *voltage detector* shall be connected to a resistance lower than R in order to have the *clear indication*.

The *clear perceptibility* of the visual indication (if any) shall be checked by performing the test of 5.3.2.1 with an ambient illumination reduced to 350 lx.

The *clear perceptibility* of the audible indication (if any) shall be checked by performing the test of 5.3.3.1 with the minimum level reduced to 53 dB for continuous sound and to 50 dB for intermittent sound.

B.6.2.2.2 Alternative tests for clear perceptibility in case of voltage detectors with continuity check having completed the production phase

For the *clear perceptibility* of the visual indication (if any), the alternative test consists of comparing the perceptibility of the visual indication of a *voltage detector* with continuity check having completed the production phase to the one of a *voltage detector* with continuity check which has passed successfully the type test according to B.6.2.2.1 (reference *voltage detector* with continuity check).

For the *clear perceptibility* of the audible indication (if any), the alternative test consists of comparing the perceptibility of the audible indication of a *voltage detector* with continuity check having completed the production phase to the one of a *voltage detector* with continuity

check which has passed successfully the type test according to B.6.2.2.1 (reference *voltage detector* with continuity check).

B.6.2.3 Check of additional marking

B.6.2.3.1 Type test

The marking required by B.6.1.2 shall be verified by visual *inspection* and measurement.

B.6.2.3.2 Alternative test in case of voltage detectors with continuity check having completed the production phase

At the production level, it is only required to check for the presence of the additional item of marking by visual *inspection*.

B.7 Classification of defects and associated requirements and tests

This subclause was developed to address the level of defects related to the supplementary function(s) of two-pole low *voltage detectors* having completed the production phase (critical, major or minor) in a consistent manner (see IEC 61318). For each requirement identified in Table B.1, both the type of defect and the associated test are specified.

Table B.1 – Classification of defects and associated requirements and tests

Requirements		Type of defects			Tests
		Critical	Major	Minor	
General					
B.2.1	Safe functioning of the *voltage detector*	X			B.3.1.2
	Performance of the *voltage detector*		X		
B.2.2	Clear visual and/or audible indication		X		B.3.2
B.2.3	Indication only in contact with bare part			X	B.3.3
B.2.4	Temperature rise			X	B.3.4
B.2.5	Absence of instructions for use		X		B.3.5.2
Additional requirements for phase indication					
B.4.2.1	Functional *Clear indication* *Clear perceptibility*		 X X		 B.4.3.1.1 B.4.3.1.2
B.4.2.2	Protection against electric shocks	X			B.4.3.2
Additional requirements for rotating field indication					
B.5.1	Compliance of the crocodile clip (if any) with IEC 61010-031	X			B.5.2.2
	Compliance with IEC 61557-7 with listed deviations		X		
Additional requirements for continuity check					
B.6.1.1	Functional *Clear indication* *Clear perceptibility*		 X X		 B.6.2.1 B.6.2.2.2
B.6.1.2	Additional marking		X		B.6.2.3.2

Annex C
(normative)

Instructions for use

C.1 General

Instructions for use shall be supplied with every *voltage detector*. It shall contain the minimum information required for use and maintenance and for the prevention of accidents. The following explanations and data shall be given.

– Information that the *voltage detector*s are designed to be used by skilled persons and in accordance with safe methods of work.

– Information about the functioning of the *indicator* and significance of the indicating signals.

– Statement indicating the *response time*, if it exceeds 500 ms.

– Explanations of the items of marking (for example, the specified *time rating* and *recovery time*, the internal impedance, the range of application, the indication of polarity, etc.).

– Statements that the voltages marked on the *voltage detector* are nominal voltages or nominal voltage ranges, and that the *voltage detector* is only to be used on installations with the specified nominal voltages or nominal voltage ranges.

– The different indicating signals of the *voltage detector* (including the ELV limit indication) are not to be used for measuring purposes.

– Before using a *voltage detector* with audible *indicator* at locations with a high background noise level, it has to be determined whether the audible signal is perceptible.

– Instructions for the proper usage of the *voltage detector* such as:

  • the use of a device corresponding to the appropriate climatic category;

  • for *voltage detectors* with replaceable *internal energy source*, exact type information on the energy source to be used;

  • the *voltage detector* is not to be used, if the battery box is open.

– Illustration of:

  • the normal use position of the *voltage detector* in order to avoid hiding the visual indication or covering the sound transmitter;

  • the correct handling of the *probe*s in order to not be touching the *contact electrode*s during use.

– Statement that the functioning of the *voltage detector* is to be checked shortly before and after use by using the *testing element*. If the indication “not ready” appears or if the indication of one or more steps fails, or if no functioning is indicated, the *voltage detector* is no longer to be used.

– For *voltage detectors* with a built-in *testing element*, explanation of the type and performance of the *testing element*.

– For *voltage detectors* without a built-in *testing element*, information on the availability and explanation of the type and performance of the suitable separate *testing element*.

– Statement of the importance to check the state of the replaceable energy source before use and to replace it if necessary.

– Statement that unauthorized persons are not to be allowed to disassemble the *voltage detector*.

– Instruction for storage and care, for example the instruction that detectors have to be kept dry and clean.

C.2 Safety advices

The following safety advices shall be included in the instructions for use.

"**SAFETY ADVICES**

Depending on the internal impedance of the *voltage detector* there will be a different capability of indicating the presence or absence of operating voltage in case of the presence of *interference voltage*.

A *voltage detector* of relatively low internal impedance, compared to the reference value of 100 kΩ, will not indicate all *interference voltage*s having an original voltage value above the ELV level. When in contact with the parts to be tested, the *voltage detector* may discharge temporarily the *interference voltage* to a level below the ELV, but it will be back to the original value when the *voltage detector* is removed.

When the indication "voltage present" does not appear, it is highly recommended installing earthing equipment before work.

A *voltage detector* of relatively high internal impedance, compared to the reference value of 100 kΩ, may not permit to clearly indicate the absence of operating voltage in case of presence of *interference voltage*.

When the indication "voltage present" appears on a part that is expected to be disconnected of the installation, it is highly recommended confirming by another means (e.g. use of an adequate *voltage detector*, visual check of the disconnecting point of the electric circuit, etc.) that there is no operating voltage on the part to be tested and to conclude that the voltage indicated by the *voltage detector* is an *interference voltage*.

A *voltage detector* declaring two values of internal impedance has passed a performance test of managing *interference voltage*s and is (within technical limits) able to distinguish operating voltage from *interference voltage* and has a means to directly or indirectly indicate which type of voltage is present."

Annex D
(normative)

General type test procedure

Table D.1 describes the sequential order for performing type tests and Table D.2 describes type tests out of sequence.

Table D.1 – Sequential order for performing type tests

Sequential order	Type test	Subclause	Requirements
1	Construction – Design	5.5.1	4.4.1, Figure 1 and Figure 2
1	Construction – Dimension	5.5.2	4.4.2 and Figure 2
1	Construction – *Testing element*	5.3.9	4.2.8
1	Construction – Indication	5.2.1	4.1.2
1	Construction – Insulating material	5.4.1.1	4.3.1
1	Construction – Current limiting element	5.4.3	4.3.3
1	*Clear indication* – Setting and scale change of *threshold voltage*	5.3.1.1.1	4.2.1.1
1	Construction – Minimum clearance and creepage distances	5.4.4	4.3.4
1	Construction – Possible disassembling	5.5.7	4.4.7
1	Construction – *Probe*(s)	5.5.10.1 5.5.10.2	4.4.10
1	Marking	5.6.1.1 5.6.2	4.5
1	Instructions for use	5.7.1	4.6, Annex C
2	Shock resistance	5.5.6.1	4.4.6
2	Drop resistance	5.5.5.1	4.4.5
2	Vibration resistance	5.5.4.1	4.4.4
3	*Clear indication* – *Threshold voltage* values	5.3.1.1.2	4.2.1.1
3	*Clear indication* – ELV indication	5.3.1.2.1	4.2.1.2
3	*Clear indication* – Continuous indication	5.3.1.4	4.2.1.3
3	*Clear indication* – Successive indication	5.3.1.5	4.2.1.4
3	Management of *interference voltages* at power frequencies	5.3.1.3.1 5.3.1.4.3.1	4.2.1.5
4	*Clear perceptibility* of visual indication	5.3.2.1	4.2.2.1
4	*Clear perceptibility* of audible indication	5.3.3.1	4.2.2.2
5	Temperature and humidity dependence of the indication	5.3.4.1.1 5.3.4.2.1	4.2.3
6	Frequency dependency for a.c. *voltage detector*	5.3.5.1.1 5.3.5.2.1	4.2.4
6	Ripple dependency for d.c. *voltage detector*	5.3.6.1.1 5.3.6.2.1	4.2.5
7	*Response time*	5.3.7.1	4.2.6
8	*Time rating*	5.3.10.1	4.2.9
8	Surface temperature	5.5.8.1	4.4.8
9	Power source dependability	5.3.8	4.2.7

Sequential order	Type test	Subclause	Requirements
9	Accessible switches for temporary loading	5.4.9.1	4.3.9
10	AC/DC voltage misuse	5.8.1	4.7.1
11	Degree of protection by enclosures (test for the protection indicated by the second characteristic numeral)	5.5.3.1	4.4.3
12	Protection against electric shocks	5.4.2.1, 5.4.6, 5.4.7, 5.4.8	4.3.2, 4.3.6, 4.3.7, 4.3.8
13	Protection against electrical stresses	5.4.5.1 5.4.5.2	4.3.5
14	Misuse in case of mistaking of the voltage of the low voltage network	5.8.3.1	4.7.3
NOTE Type tests with the same sequential number can be performed in the more convenient order.			

Table D.2 – Type tests out of sequence

Type test	Subclause	Requirements
Test on the insulation – Test on the complete equipment	5.4.1.2.1 5.4.1.2.2 5.4.1.2.3.1	4.3.1
Maximum current to earth in case of misuse	5.8.2.1	4.7.2
Close adhesion of insulation of the insulated part of the *contact electrode* (when provided)	5.5.10.3.1	4.4.10
Dimensional check of *lead*(s)	5.5.11.1.1	4.4.11
Tensile test (for detachable *probe* only)	5.5.11.1.2	
Pull relief test	5.5.11.1.3	
Lead attachment – Pull test	5.5.11.1.4	
Flexing/pull test	5.5.11.1.5	
Rotational/flexing test	5.5.11.1.6	
Wear test	5.5.11.1.7	
Electromagnetic compatibility (EMC)	5.2.2.1 5.3.1.3.2	4.1.3, 4.2.1.3
Resistance to heat	5.5.9.1	4.4.9
Degree of protection by enclosure (test for the protection indicated by the first characteristic numeral)	5.5.3.1	4.4.3
NOTE Type tests can be performed on extra *voltage detectors* or test pieces where appropriate.		

Annex E
(normative)

Classification of defects and associated requirements and tests

This annex was developed to address the level of defects of two-pole low *voltage detectors* having completed the production phase (critical, major or minor) in a consistent manner (see IEC 61318). For each requirement identified in Table E.1, both the type of defect and the associated test are specified.

Table E.1 – Classification of defects and associated requirements and tests

Requirements		Type of defects			Tests
		Critical	Major	Minor	
4.2.1.2	ELV indication/Indication of hazardous voltage	X			5.3.1.2.1 or 5.3.1.2.2
4.2.1.1	*Threshold voltage*		X		5.3.1.1.2
4.2.3	Temperature and humidity dependence of the indication – *Threshold voltage* and ELV	X (ELV)	X (*Threshold voltage*)		5.3.4.1.2
4.2.4	Frequency dependency for a.c. *voltage detector*– *Threshold voltage* and ELV	X (ELV)	X (*Threshold voltage*)		5.3.5.1.2
	Frequency dependency for a.c. *voltage detector*– Perceptibility of the indication(s)		X		5.3.5.2.2
4.2.5	Ripple dependency for d.c. *voltage detector*– *Threshold voltage* and ELV	X (ELV)	X (*Threshold voltage*)		5.3.6.1.2
	Ripple dependency for d.c. *voltage detector*– Perceptibility of the indication(s)		X		5.3.6.2.2
4.3.2 4.3.6 4.3.7 4.3.8	Protection against electric shocks	X			5.4.2.2
4.3.1	Insulating material	X			5.4.1.2.3.2
4.7.1	AC/DC voltage misuse	X			5.8.1
4.7.2	Maximum current to earth in case of misuse		X		5.8.2.2
4.3.5	Protection against electrical stresses – *Transient overvoltage* *Temporary overvoltage*	 X	X		5.4.5.3
4.2.7	Power source dependability			X	5.3.8
4.2.6	*Response time*	X			5.3.7.2
4.7.3	Misuse in case of mistaking of the voltage of the low voltage network	X			5.8.3.2
4.1.3 4.2.1.3	EMC Emission Immunity (ELV) Immunity (*Threshold voltage*)	 X	 X	X	5.2.2.2
4.4.3	Degree of protection by enclosures	X			5.5.3.2
4.2.1.3	Continuous indication – Indication only in contact with bare part			X	5.3.1.4.1

Requirements		Type of defects			Tests
		Critical	Major	Minor	
4.2.1.5	Management of *interference voltages* at power frequencies		X		5.3.1.3.2 5.3.1.4.3.2[a]
4.2.2.1	Perceptibility of the visual indication		X		5.3.2.2
4.2.2.2	Perceptibility of the audible indication		X		5.3.3.2
4.2.3	Temperature and humidity dependence – Perceptibility of the indication(s)		X		5.3.4.2.2
4.2.8	*Testing element*		X		5.3.9
4.2.9	*Time rating*		X		5.3.10.2
4.2.1.4	Successive indication		X		5.3.1.5
4.5.1	Marking (Absence of marking)	X			5.6.1.2
4.6	Instructions for use (Absence of instructions for use)		X		5.7.2
4.4.4	Vibration resistance		X		5.5.4.2
4.4.5	Drop resistance		X		5.5.5.2
4.4.6	Shock resistance		X		5.5.6.2
4.5.1	Marking (Durability of marking)			X	5.6
4.4.8	Surface temperature			X	5.5.8.2
4.4.11	Tensile test (for detachable *probe* only) Pull relief test *Lead* attachment – Pull test Flexing/pull test Rotational/flexing test Wear test		X	X X X X X	5.5.11.2
4.4.10	Close adhesion of insulation of the insulated part of the *contact electrode* (when provided)			X	5.5.10.3.2
4.4.9	Heat resistance			X	5.5.9.2

[a] For a *voltage detector* claiming to be able to distinguish an operating voltage from an *interference voltage*

Annex F
(informative)

In-service care and use

F.1 Use and storage

The *voltage detector* should only be used and stored as specified in the manufacturer's instructions for use.

Care should be taken to make sure that handling and working conditions are in accordance with the manufacturer's instruction for use.

Use only accessories specified by the manufacturer.

Do not apply to the *voltage detector* more than the nominal voltage (or upper value of the nominal voltage range) as indicated in the marking.

Check, before and after use, the functioning of the *voltage detector* either by means of the *testing element* made available by the manufacturer, or with a reference voltage source if available.

During test do not touch the bare part of the *contact electrode*s and keep the fingers behind the *hand-guard*.

F.2 Inspection before use

When a *voltage detector* is to be used, a visual *inspection* should be done.

Check if the battery box is correctly secured.

Do not use a *voltage detector* if it appears damaged. Look for cracks or missing parts, pay attention to the insulation of the *lead*s, connectors and *probe*s.

If there is a serious concern that the device is not in good condition, it should be returned to the manufacturer or authorized facility for repair or rejection.

F.3 Maintenance

F.3.1 Regular maintenance

The user should adhere to the following:

– Periodically wipe the *voltage detector* with a cloth soaked with alcohol or mild detergent. Do not use acid or abrasive solvents. After wiping, let the *voltage detector* dry. During the cleaning, be careful not to leave the *voltage detector* connected to live parts.
– Shake out any dirt that may be in the connecting points.
– Replace the batteries as soon as the non-readiness signal appears and install only specified models of batteries as mentioned in the instructions for use. Be sure the *voltage detector* is not connected to live parts while installing the batteries. Respect the correct polarity.
– Do not try to disassemble the enclosures of the *voltage detector*.

– For servicing the *voltage detector*, use only specified replacement parts.

F.3.2 Periodic maintenance

Periodic maintenance on devices for live working is recognized as a basis for insuring their good functioning and the safety of the user.

It is recommended that the periodic maintenance be done by the manufacturer or at an agreed trained repair facility.

It is the responsibility of the owner to outline the maintenance schedule, taking into account the use conditions (storage, regular care, training of the user, etc). However no *voltage detector*, even those held in storage, should be used unless re-testing within a maximum period of 6 years.

F.3.3 Periodic testing

Table F.1 lists the tests which permit periodic verification of the physical integrity, the functioning of the *voltage detector* and its insulation performance.

Table F.1 – Periodic testing

Subclauses	Designation
	Visual and dimensional *inspection* [a]
5.3.9.1	*Testing element*
5.3.1.1.2/5.3.1.2.1	*Threshold voltage* and ELV values [b]
5.3.2.2	*Clear perceptibility* of visual indication
5.3.3.2	*Clear perceptibility* of audible indication
5.3.10.1	*Time rating*
5.4.1.2.3.2	AC voltage test [c]

[a] The *inspection* should also include the checking of the integrity of the *voltage detector*, the presence and sound condition of all the components, accessories, instructions for use and carrying bag.

[b] For ELV value the battery should be removed for the test wherever possible.

[c] This test may be performed without damp heat preconditioning and for 1 s.

According to the design of the *voltage detector* and its fabrication process, the manufacturer may specify additional tests related to particular components or characteristics.

Annex G
(informative)

Voltage detectors and the presence of interference voltages

G.1 General

According to the definition of a *voltage detector* for live working, when the part to be tested is connected to an electric network, that is when the operating voltage is present, the purpose of the *voltage detector* is to indicate clearly the presence of this operating voltage.

However, it may happen that when the part to be tested is disconnected from the electric network there is still presence of voltage usually due to capacitive or inductive coupling with live installations nearby. These voltages are called "*interference voltage*s" (see 3.11) and may be harmful or not depending of the characteristics of the coupling.

To avoid any uncontrolled reactions of the user due to a circulating current higher than 0,5 mA through the body in combination with *interference voltage*s, the reference value of internal impedance of a *voltage detector* is set to 100 kΩ. A *voltage detector* with a higher internal impedance than the reference value will always indicate "voltage present" at or above ELV level (50 V a.c.) in case the coupled source (operating or *interference voltage*) is able to drive a circulating current higher than 0,5 mA.

G.2 Voltage detectors with the capability of suppressing or reducing significantly the level of interference voltages – relatively low internal impedance (< 100 kΩ)

Voltage detectors with relatively low internal impedance always provide the user with a *clear indication* of the presence or absence of operating voltage. But in cases of a strong coupling of a disconnected part and nearby installations, the *voltage detector* would temporarily suppress induced *interference voltage* or reduce it at a level lower than the ELV, so that its presence will not be indicated. The lower the internal impedance the more likely is the possibility for the *voltage detector* to give no indication of *interference voltage*s. Because of that, it is required that a safety advice is included in the instructions for use to warn the user of the possible hazard and to recommend the installation of an earthing equipment before initiating any "dead working" procedure (see Clause C.2)

Nevertheless, due to the wide range of "relatively low" internal impedance combined with the characteristics of the capacitive coupling on the part to be tested (which vary with on-site installation configurations) *interference voltage* with values above the ELV may also be indicated

NOTE *Voltage detectors* of relatively low internal impedance are generally not designed for use on *secondary networks* or on equipment where the use of such temporary load would activate insulation monitoring systems, residual current devices or other sensor circuits.

G.3 Voltage detectors with the capability of discriminating an operating voltage from an interference voltage

These devices are designed in such a way that they can detect the presence of any voltage on the part to be tested and, in case of an *interference voltage*, they can confirm the absence of the operating voltage and the presence of an *interference voltage* or assist the user in identifying the status of the voltage (operating or interference). These devices are basically devices where its initial internal impedance can be reduced so that the temporary additional load connected to the part to be tested would decrease the level of an *interference voltage*.

This type of *voltage detector* respects the purpose of a *voltage detector* for live working. It always provides the user with a *clear indication* of the presence or absence of the operating voltage, but it also confirms the presence of an *interference voltage*, if any.

In terms of managing *interference voltages*, and taking into account the varieties of installation configurations, there is also a theoretical limit to the performance of *voltage detectors* with the capability of distinguishing an operating voltage from an *interference voltage*. When the coupling with live installations nearby is very high, some devices may not perform correctly and may indicate “presence of an operating voltage” when it is actually an *interference voltage*. This is an incorrect indication but it does not compromise the functional safety of the device.

NOTE 1 *Voltage detectors* with the capability of distinguishing an operating voltage from an *interference voltage* are generally not designed for use on *secondary networks* or on equipment where the use of such temporary load would activate insulation monitoring systems, residual current devices or other sensor circuits.

NOTE 2 In case of *voltage detectors* with the capability of distinguishing an operating voltage from an *interference voltage* with a load that is manually activated (ex: push buttons), the *voltage detector* without activation of this load usually works as a *voltage detector* with relatively high internal impedance and is considered as such (see G.4). In such case, the previous note does not apply.

G.4 Voltage detectors with no capability of suppressing or reducing significantly the level of interference voltages – relatively high internal impedance (> 100 kΩ)

Due to the classification criterion of *voltage detector*s of relatively high internal impedance (which permits a wide range), the higher is its internal impedance the likely is the possibility for the *voltage detector* to not suppress or not reduce significantly the level of *interference voltages*.

In the presence of an *interference voltage* on a disconnected part of the electric network, this type of *voltage detector* will not always provide the user a *clear indication* of the presence or absence of the operating voltage.

In such case, the worker should be advised that installing an earthing equipment or initiating any “dead working” procedure is not safe, until an additional means is used (use of an adequate type of *voltage detector*, visual *inspection* of the opening point of the network, if possible, etc.) to confirm clearly the absence of operating voltage.

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[5] First edition, replaced by asecond edition in 2013. There exists a consolidated edition 1.1, including IEC 60721-2-1:1982 and its Amendment 1.

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