

BRITISH STANDARD

**BS 7739 :
Part 1 : 1994
IEC 1243-1 :
1993**

Voltage detectors

**Part 1. Specification for capacitive type
to be used for voltage exceeding 1 kV a.c.**

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Power Electrical Engineering Standards Policy Committee (PEL/-) to Technical Committee PEL/88, upon which the following bodies were represented:

- Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)
- BECCAMA (BEAMA Electrical Cable Connector and Accessories Manufacturer's Association)
- British Railways Board
- Department of Trade and Industry
- Department of Trade and Industry (Consumer Safety Unit, CA Division)
- Electricity Association
- Federation of British Hand Tool Manufacturers
- GAMBICA (BEAMA Ltd.)
- Health and Safety Executive
- Industrial Safety (Protective Equipment) Manufacturers' Association
- International Powered Access Federation
- Ministry of Defence
- National Association of Glove Manufacturers
- Coopted member

This British Standard, having been prepared under the direction of the Power Electrical Engineering Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 March 1994

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The following BSI references relate to the work on this standard:
Committee reference PEL/88
Draft for comment 89/27325 DC

ISBN 0 580 22954 8

Amendments issued since publication

Amd. No.	Date	Text affected

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National foreword

This Part of BS 7739 has been prepared under the direction of the Power Electrical Engineering Standards Policy Committee. It is identical to IEC 1243-1 : 1993 published by the International Electrotechnical Commission (IEC).

This standard is the first part of a series of publications on voltage detectors that are being considered by IEC TC 78. Annexes A, B, C, D and E are normative and form part of this standard. Annex F is for information only.

The graphic signs, symbols and letters used in this standard may be found in the following British Standards:

BS 3939	<i>Graphic symbols for electrical power, telecommunications and electronic diagrams</i>
Part 1 : 1986	<i>General information, general index</i> (Related to IEC 617-1)
Part 2 : 1985	<i>Symbol elements, qualifying symbols and other symbols having general application</i> (Identical with IEC 617-2)

Cross-references

International standard	Corresponding British Standard
	BS 4727 <i>Glossary of electrotechnical, power, telecommunications, electronics, lighting and colour terms</i>
IEC 50-151 : 1978	Part 1 <i>Terms common to power, telecommunications and electronics</i> Group 02 : 1980 <i>Electrical and magnetic devices terminology</i> (Technically equivalent)
IEC 50-601 : 1985	Part 2 <i>Terms particular to power engineering</i> Group 11 : 1986 <i>Generation, transmission and distribution of electricity terminology</i> (Technically equivalent)
IEC 60-1 : 1989	BS 923 <i>Guide on high-voltage testing techniques</i> Part 1 : 1990 <i>General</i> (Identical)
IEC 68-1 : 1988	BS 2011 <i>Environmental testing</i> Part 1.1 : 1989 <i>General and guidance</i> (Identical)
IEC 68-2-6 : 1982	Part 2.1Fc : 1983 <i>Test Fc. Vibration (sinusoidal)</i> (Identical)
IEC 68-2-14 : 1984	Part 2.1N : 1985 <i>Test N. Change of temperature</i> (Identical)
IEC 68-2-32 : 1975	Part 2.1Ed : 1992 <i>Test Ed. Free fall</i> (Identical)
IEC 68-2-43 : 1976	Part 2.1 Kd : 1977 <i>Test Kd. Hydrogen sulphide test for contacts and connections</i> (Identical)
IEC 71-1 : 1976	BS 5622 <i>Guide for insulation co-ordination</i> Part 1 : 1979 <i>Terms, definitions, principles and rules</i> (Identical)
IEC 651 : 1979	BS 5969 : 1981 <i>Specification for sound level meters</i> (Identical)

IEC 855 : 1985	BS 7695 : 1994 <i>Specification for insulating foam-filled tubes and solid rods for live working</i> (Technically equivalent)
ISO 3745 : 1977	BS 4196 <i>Sound power levels of noise sources</i> Part 5 : 1981 <i>Precision methods for determination of sound power levels for sources in anechoic and semi-anechoic rooms</i> (Identical)

The Technical Committee has reviewed the provisions of IEC 410 : 1973, to which normative reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

LIVE WORKING – VOLTAGE DETECTORS –

Part 1: Capacitive type to be used for voltages exceeding 1 kV a.c.

1 Scope

This part of IEC 1243 is applicable to portable voltage detectors, with or without built-in power sources, to be used on electrical systems for voltages of 1 kV to 420 kV a.c., and frequencies from 15 Hz to 60 Hz. Detectors for voltages above 420 kV a.c. are under consideration.

This part applies only to capacitive voltage detectors used in contact with the component to be tested, as a single unit including its insulating pole, or as a separate device completed by an adaptable insulating pole covered in IEC 855.

Some restrictions on their use are applicable in the case of factory-assembled switchgear and on overhead systems of electrified railways (see annex B, instructions for use).

Other types of voltage detectors are not covered by this part of standard.

NOTE - Except where otherwise specified, all the voltages defined in this standard refer to values of phase-to-phase voltages of three-phase systems. In other systems, the applicable phase-to-phase or phase-to-earth (ground) voltages should be used to determine the operating voltage.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 1243. At the time of publication of this standard, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 1243 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 50(151): 1978, *International Electrotechnical Vocabulary (IEV) – Chapter 151: Electrical and magnetic devices*

IEC 50(601): 1985, *International Electrotechnical Vocabulary (IEV) – Chapter 601: Generation, transmission and distribution of electricity – General*

IEC 60-1: 1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 68-1: 1988, *Environmental testing – Part 1: General and guidance*

IEC 68-2-6: 1982, *Environmental testing – Tests – Test Fc and guidance: Vibration (sinusoidal)*

IEC 68-2-14: 1984, *Environmental testing – Tests – Test N: Change of temperature*

IEC 68-2-32: 1975, *Environmental testing – Tests – Test Ed: Free fall*
Amendment 2 (1990)

IEC 68-2-43: 1976, *Environmental testing – Tests – Test Kd: Hydrogen sulphide test for contacts and connections*

IEC 71-1: 1976, *Insulation co-ordination – Part 1: Terms, definitions, principles and rules*

IEC 410: 1973, *Sampling plans and procedures for inspection by attributes*

IEC 651: 1979, *Sound level meters*

IEC 855: 1985, *Insulating foam-filled tubes and solid rods for live working*

ISO 3745: 1977, *Acoustics determination of sound power levels of noise sources – Precision methods for anechoic and semi-anechoic rooms*

3 Definitions

For the purposes of this part of IEC 1243, the following definitions apply.

3.1 voltage detector: Portable device used to detect the presence or the absence of the operating voltage.

3.2 capacitive detector (detector): Device used to indicate voltage by detecting the current passing through the stray capacitance to earth (ground).

3.3 resistive detector: Device whose operation is based on the current passing through a resistor located in the resistance element, and a galvanic connection to earth (ground).

3.4 types of detectors: Single unit including its insulating element, with or without contact electrode extension.

Separate unit completed with an insulating pole, with or without contact electrode extension.

3.5 contact electrode: Bare conductive part of the conductive element which establishes the electrical connection to the component to be tested.

3.6 contact electrode extension: Externally insulated conductive section between the indicator and the contact electrode, intended to achieve the correct position of the indicator relative to the installation being tested.

3.7 Indicator: Part of the detector which indicates the presence or absence of the operating voltage at the contact electrode.

3.8 adaptor: Part allowing the assembly of the detector.

3.9 insulating element: Section of insulating material which provides adequate distance and insulation to the user.

3.10 Insulating pole: Pole made of insulating material

3.11 limit mark: Distinctive location or mark to indicate to the user the physical limit to which the detector may be inserted between live components or may touch them.

3.12 hand guard: Distinctive physical guard separating the handle from the insulating element.

NOTE - Its purpose is to prevent the hands from slipping and passing into contact with the insulating element.

3.13 testing element: Built-in or external device, by means of which the functioning of the detector can be checked by the user.

3.14 accessories: Items used to lengthen the handle or the contact electrode, to improve the efficiency of the contact electrode or to enable the contact electrode to reach the part to be tested.

3.15 nominal voltage (U_n): Suitable approximate value of voltage used to identify a system or device. [IEV 601-01-21]

Nominal voltage of the detector is the parameter associated with its clear indication. Detector may have more than one nominal voltage, or a nominal voltage range. Limit values of the nominal voltage range are named U_n min and U_n max.

3.16 threshold voltage (U_t): Minimum voltage between the live component and earth (ground) required to give a clear indication corresponding to specific conditions as defined in the corresponding test.

3.17 rated voltage (U_r): Value of voltage generally agreed upon by manufacturer and customer, to which certain operating specifications are referred.

The rated voltage of the detector is the voltage selected from IEC 71-1, tables 1, 3 and 4, column 1, which should either be equal to the nominal voltage (or the highest nominal voltage of its nominal voltage range), or the next higher voltage selected from those tables.

3.18 Interference voltage: Voltage picked up inductively or capacitively by the component to be tested.

3.19 Interference field: Electrical field affecting the indication. It may result from the component to be tested or other adjacent components, and may have any phase relationship.

The extreme cases for the tests are:

- an in-phase interference field exists when a small change of potential in the direction of the detector axis results in an incorrect indication. This occurs as a result of the dimensions of the part of installation to be tested (or of adjacent parts of the installation having voltages in the same phase);
- an interference field in phase opposition exists when a strong change of potential in the direction of the detector axis results in an incorrect indication. This occurs as a result of the adjacent parts of the installation having voltages in phase opposition.

3.20 clear indication: Unambiguous detection and indication of the voltage state at the contact electrode.

3.21 clear perceptibility: Case where the indication is unmistakably discernible by the user under specific environmental conditions when the detector is in its operating position.

3.22 response time: Time delay between sudden change of the voltage state on the contact electrode and the associated clear indication.

3.23 protection against bridging: Protection against flashover or breakdown, when the insulation between the parts of installation to be tested, at different potentials, is reduced by the presence of the detector.

3.24 stand-by state: State at which the detector is ready to work at the threshold voltage without manual switching on.

3.25 Indoor type: Detector designed for use in dry conditions, normally indoors.

3.26 outdoor type: Detector designed for use in wet conditions, either indoors or outdoors.

IEV definitions

3.27 type test: Test on one or more devices of a certain design to show that the design meets established specifications. [IEV 151-04-15]

3.28 routine test: Test to which each individual device is subjected during or after manufacture to ascertain whether it complies with certain criteria. [IEV 151-04-16]

3.29 sampling test: Test on a number of devices taken at random from a batch. [IEV 151-04-17].

3.30 acceptance test: Contractual test to prove to the customer that the device meets certain conditions of its specification. [IEV 151-04-20]

3.31 maintenance test: Test carried out periodically on a device or equipment to ascertain and, if necessary, make certain adjustments to ensure that its performance remains within specified limits. [IEV 151-04-22]

4 Requirements

4.1 General

When a contact electrode extension is required for the proper operation of the detector, all tests shall be performed with the contact electrode extension in place.

4.1.1 Safety

The detector shall be designed and manufactured to be safe for the user, provided it is used in accordance with safe methods of work, and the instructions for use.

4.1.2 Indication

The detector shall give a clear indication of the state "voltage present" or/and "voltage not present", by means of the change of the status of the signal. The indication shall be visual and/or audible.

4.2 Functional

4.2.1 Clear indication

4.2.1.1 The detector shall clearly indicate the system operating voltage as a function of its nominal voltage or nominal voltage range, and its nominal frequency or nominal frequency range.

Manufacturer and customer shall agree on one of the four following classes:

- Class A: Detector with a single nominal voltage or several switchable nominal voltages.

The threshold voltage U_t shall satisfy the following relationship:

$$0,15 U_n \leq U_t \leq 0,40 U_n$$

- Class B: Detector with a narrow range of nominal voltages, e.g.:

$$U_n \text{ max.} = 2 U_n$$

- The threshold voltage U_t shall satisfy the relationship:

$$0,15 U_n \text{ max.} \leq U_t \leq 0,40 U_n \text{ min.}$$

- Class C: Detector with a wide range of nominal voltages, e.g.:

$$U_n \text{ max.} = 3 U_n \text{ min.}$$

The threshold voltage U_t shall satisfy the following relationship:

$$0,10 U_n \text{ max.} \leq U_t \leq 0,45 U_n \text{ min.}$$

- Class D: If it is not possible to use any of the above-mentioned classes, because of the layout of electrical installations combined with the presence of interference fields, the manufacturer and customer shall reach an agreement to set the appropriate value of U_t .

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

4.2.1.3 The detector shall give continuous indication when in direct contact with a live part.

4.2.1.4 The presence of an adjacent live or earthed part shall not affect the indication when used in accordance with instructions.

The detector shall not indicate usual values of interference voltages. The presence of an interference field shall not affect the indication.

4.2.2 Clear perceptibility

The detector shall give a clear indication of the system voltage under normal light and noise conditions.

The types of indications of detector are divided into three groups:

- group I: Indication with at least two distinct active signals, which give an indication of the condition "voltage present" and "voltage not present". The "stand-by" state is not necessary;
- group II: Indication with one active signal, which gives an indication of the condition "voltage not present" and is activated by manually switching "on", and is suppressed when the contact electrode is put into contact with a live component;
- group III: Indication with one active signal, which gives an indication of the condition "voltage present", and shall have a stand-by state.

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 two signals are used, the indication shall not rely solely on light of different colours for perceptibility. Additional characteristics, such as physical separation of the light sources, distinctive form of the light signals, or flashing light shall be used.

4.2.2.2 Audible indication

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

4.2.3 Temperature and humidity dependence of the indication

There are three categories of detectors according to climatic conditions of operation: cold (C), normal (N), and warm (W).

The detector shall operate correctly in the temperature range of its climatic category, according to table 1.

The threshold voltage shall not vary by more than $\pm 10\%$, with respect to the threshold voltage measured at the standard atmospheric conditions.

Table 1 – Climatic categories

Climatic categories	Climatic conditions ranges (operation and storage)	
	Temperature °C	Humidity %
Cold (C)	– 40 to +55	20 to 96
Normal (N)	– 25 to +55	20 to 96
Warm (W)	– 5 to +70	12 to 96

4.2.4 Frequency dependence

The detector shall operate correctly between 97 % of the lower frequency and 103 % of the higher frequency of the frequency range.

A detector with more than one nominal frequency shall operate for each frequency between 97 % and 103 % of the nominal frequency.

4.2.5 *Response time*

The response time shall be less than 1 s.

4.2.6 *Power source dependability*

A detector with a built-in power source shall give a clear indication until the source is exhausted, unless its usage is limited by an indication of non-readiness or automatic shut-off as mentioned in the instructions for use.

4.2.7 *Testing element*

The testing element, whether built-in or a separate item, shall be capable of testing all the electrical circuits, including energy source and the functioning of the indication. When all circuits cannot be tested, any limitation shall be clearly stated in the instructions for use, and these circuits shall be constructed with high reliability. When there is a built-in testing element, the detector shall give an indication of "ready" or "not ready".

4.2.8 *No response to d.c. voltage*

The detector shall not respond to a d.c. voltage.

4.2.9 *Time rating*

The detector shall be able to perform without failure when subjected to the rated voltage for 5 min.

4.3 *Electrical requirements*

4.3.1 *Insulating material*

The insulating material shall be adequately rated for the nominal voltage.

4.3.2 *Protection against bridging*

Protection shall be such that the detector cannot cause flashover or breakdown between live parts of an installation or between a live part of an installation and earth.

4.3.3 *Resistance against sparking*

The detector shall be constructed so that the indicator cannot be damaged or shut off as a result of spark discharge.

4.4 Mechanical requirements

4.4.1 Design

4.4.1.1 Detector as a complete unit

- a) The detector as a single unit shall include at least the following elements: insulating pole comprising the handle and the insulating element, indicator, and contact electrode (see figure 1a).
- b) The detector as a separate unit shall include at least: indicator, contact electrode, adaptor, and insulating pole (handle and insulating element) (see figure 1b).

4.4.1.2 The detector shall not have any external conductive connection, or any other device to make such connection, except for the contact electrode.

4.4.1.3 Classification

- The detector without contact electrode extension shall have category marking L. It is used mainly on overhead lines.
- The detector with contact electrode extension shall have category marking S. It is mainly used in indoor substations.

4.4.2 Dimensions, construction

The minimum length of the insulating element shall be in accordance with table 2.

Table 2 – Minimum length of the insulating element (L_i min.)

U_r kV	L_i mm
up to 36	525
$36 < U_r \leq 72,5$	900
$72,5 < U_r \leq 123$	1 300
$123 < U_r \leq 170$	1 750
$170 < U_r \leq 245$	2 400
$245 < U_r \leq 420$	3 200

Conductive parts not exceeding 200 mm (in total), measured from the limit mark towards the handle, are allowed within the minimum length of the insulating element if they are completely insulated.

When provided, the limit mark shall be about 20 mm wide, permanent, and clearly recognizable by the user. When the detector as a separate unit is completed by an insulating pole, the limit mark may be replaced by the adaptor.

When provided, the handle shall be at least 115 mm in length.

NOTE - The handle may be made longer for two-hand operation.

When provided, the hand guard shall be permanently fixed, and have a minimum thickness h_{HG} of 20 mm.

In order to adapt the detector to different uses, the contact electrode readily may be interchangeable with other types of contact electrodes depending on the type of installation and instruction for use. If several contact electrodes are used, the threshold voltage test, protection against bridging tests and other relevant tests shall be performed using each contact electrode.

The maximum length of the bare portion of the contact electrode is given in table 3.

Table 3 – Maximum length of bare portion of contact electrode

U_n or U_n min. (range) kV	Maximum length mm
1 < U_n ≤ 3,6	25
3,6 < U_n ≤ 12	40
12 < U_n ≤ 24	60
24 < U_n ≤ 36	80
36 < U_n ≤ 52	150
52 < U_n ≤ 72,5	300
72,5 < U_n ≤ 420	400

NOTES

- 1 For a detector with a nominal voltage range, the voltage U_n min. given in table 3 shall be used.
- 2 For certain applications, other values may be agreed between manufacturer and customer.

4.4.3 Grip force and deflection

The detector shall be designed to facilitate reliable operation with reasonable physical effort by the user.

The grip force shall not exceed 200 N.

The detector shall be designed to allow a safe approach towards the installation to be tested. The deflection under its own weight shall be as low as possible, and shall not exceed 10 % for the total length of the complete unit, measured in the horizontal position.

The weight of the indicator shall be minimal and compatible with the performance requirements.

4.4.4 Vibration resistance

The indicator and contact electrode extension shall be vibration resistant.

4.4.5 Drop resistance

The detector shall be drop resistant.

4.4.6 Shock resistance

The indicator and contact electrode extension shall withstand mechanical shocks, according to annex D.