

INTERNATIONAL STANDARD

NORME INTERNATIONALE



BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

**Basic and safety principles for man-machine interface, marking and identification –
Identification of equipment terminals, conductor terminations and conductors**

**Principes fondamentaux et de sécurité pour les interfaces homme-machines, le
marquage et l'identification –
Identification des bornes de matériels, des extrémités de conducteurs et des
conducteurs**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**BASIC AND SAFETY PRINCIPLES FOR MAN-MACHINE
INTERFACE, MARKING AND IDENTIFICATION –
IDENTIFICATION OF EQUIPMENT TERMINALS, CONDUCTOR
TERMINATIONS AND CONDUCTORS**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60445 has been prepared by IEC technical committee 16: Basic and safety principles for man-machine interface, marking and identification.

This fifth edition is a merged version of IEC 60445 and IEC 60446, and cancels and replaces the fourth edition of IEC 60445, published in 2006, and the fourth edition of IEC 60446, published in 2007.

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

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

- a) addition of new definitions in Clause 3;
- b) revision of some clauses to use words from reference IEC standards. These revisions did not change any technical requirements but to clarify the wording;

c) addition of Annex B (informative) “List of notes concerning certain countries”.

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

FDIS	Report on voting
16/479/FDIS	16/480/RVD

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

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

The reader’s attention is drawn to the fact that Annex B lists all of the “in-some-country” clauses on differing practices of a less permanent nature relating to the subject of this standard.

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

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

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

INTRODUCTION

This basic safety publication is primarily intended for use by technical committees in the preparation of standards in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

It is not intended for use by manufacturers or certification bodies. One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. The requirements of this basic safety publication will not apply unless specifically referred to or included in the relevant publications.

In this fifth edition of IEC 60445, the terminology has been aligned with IEC 60050-195.

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[IEC 60445:2010](https://standards.iteh.ai/catalog/standards/sist/4702b037-ce6e-4a6f-9b0b-49e88e91d824/iec-60445-2010)

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Withhold

BASIC AND SAFETY PRINCIPLES FOR MAN-MACHINE INTERFACE, MARKING AND IDENTIFICATION – IDENTIFICATION OF EQUIPMENT TERMINALS, CONDUCTOR TERMINATIONS AND CONDUCTORS

1 Scope

This International Standard applies to the identification and marking of terminals of electrical equipment such as resistors, fuses, relays, contactors, transformers, rotating machines and, wherever applicable, to combinations of such equipment (e.g. assemblies), and also applies to the identification of terminations of certain designated conductors. It also provides general rules for the use of certain colours or alphanumeric notations to identify conductors with the aim of avoiding ambiguity and ensuring safe operation. These conductor colours or alphanumeric notations are intended to be applied in cables or cores, busbars, electrical equipment and installations.

2 Normative references

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

IEC 60417, *Graphical symbols for use on equipment*

IEC 60617, *Graphical symbols for diagrams*

IEC Guide 104, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51, *Safety aspects – Guidelines for their inclusion in standards*

3 Terms and definitions

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

NOTE The terms are sorted in alphabetical order in the English language.

3.1

electrical equipment

item used for purposes like generation, conversion, distribution or utilization of electric energy (e.g. electrical machines, transformers, switchgear and controlgear, measuring instruments, wiring systems, current-using equipment, etc.)

[IEC 60050-826:2004, 826-16-01, modified]

3.2

functional bonding conductor

conductor provided for functional- equipotential bonding

[IEC 60050-195:1998, 195-02-16]

3.3

functional earthing

functional grounding (in US)

earthing a point or points in a system or in an installation or in equipment, for purposes other than electrical safety

[IEC 60050-195, Amendment 1:2001, 195-01-13]

3.4

functional earthing conductor

functional grounding conductor (in US)

earthing conductor provided for functional earthing

[IEC 60050-195, 195-02-15]

3.5

functional-equipotential-bonding

equipotential bonding for operational reasons other than safety

[IEC 60050-195, 195-01-16]

3.6

line conductor

phase conductor (in AC systems) (deprecated)

pole conductor (in DC systems) (deprecated)

conductor which is energized in normal operation and capable of contributing to the transmission or distribution of electric energy but which is not a neutral or mid-point conductor

[IEC 60050-195, 195-02-08]

3.7

mid-point conductor

conductor electrically connected to the mid-point and capable of contributing to the distribution of electric energy

[IEC 60050-195, 195-02-07]

3.8

neutral conductor

conductor electrically connected to the neutral point and capable of contributing to the distribution of electric energy

[IEC 60050-195, 195-02-06]

3.9

PEL conductor

conductor combining the functions of both a protective earthing conductor and a line conductor

[IEC 60050-195, 195-02-14]

3.10

PEM conductor

conductor combining the functions of both a protective earthing conductor and a mid-point conductor

[IEC 60050-195, 195-02-13]

3.11**PEN conductor**

conductor combining the functions of both a protective earthing conductor and a neutral conductor

[IEC 60050-195, 195-02-12]

3.12**protective bonding conductor**

equipotential bonding conductor (deprecated)

protective conductor provided for protective-equipotential-bonding

[IEC 60050-195, 195-02-10]

3.13**protective bonding conductor, earthed**

protective bonding conductor with a conductive path to earth

3.14**protective bonding conductor, unearthed**

protective bonding conductor without a conductive path to earth

3.15**protective conductor**

(identification: PE)

conductor provided for purposes of safety, for example protection against electric shock

[IEC 60050-195, 195-02-09]

3.16**protective earthing****protective grounding (in US)**

earthing a point or points in a system or in an installation or in equipment, for purposes of electrical safety

[IEC 60050-195, Amendment 1:2001, 195-01-11]

3.17**protective earthing conductor****protective grounding conductor (in US)**

protective conductor provided for protective earthing

[IEC 60050-195:1998, 195-02-11]

3.18**protective-equipotential-bonding**

equipotential bonding for the purposes of safety

[IEC 60050-195:1998, 195-01-15]

4 Methods of identification

Where the identification of equipment terminals and of terminations of certain designated conductors is considered necessary, it shall be effected by the use of one or more of the following methods:

- the physical or relative location of the equipment terminals or of terminations of certain designated conductors;

- a colour code for equipment terminals and terminations of certain designated conductors in accordance with Clause 6;
- graphical symbols in accordance with IEC 60417. If additional symbols are required, these shall be consistent with IEC 60617;
- an alphanumeric notation in accordance with the system laid down in Clause 7.

To keep consistency with the documentation, conductor and equipment terminal designation, the alphanumeric notation is recommended.

Identification of conductors by colours shall be in accordance with the requirements provided in Clause 6. Identification of conductors by alphanumeric notation shall be in accordance with the requirements provided in Clause 7.

NOTE It is recognised that for complex systems and installations additional marking and labelling may be needed for reasons other than safety, see for example IEC 62491.

5 Application of identification means

The identifying colour, graphical symbol or alphanumeric notation shall be located on, or adjacent to, the corresponding terminal.

When more than one identification method is used and confusion is possible, the correlation between the methods shall be clarified in the associated documentation.

When no confusion is possible, the juxtaposition of numerical and alphanumeric notation may be applied.

Terminals/conductors used for earthing are divided concerning their purpose of earthing into the two basic concept of protective earthing and functional earthing.

- If a terminal or conductor fulfils the requirements for both protective earthing and functional earthing, it shall be designated as a protective earthing terminal/conductor.
- If the requirements for protective earthing are not met by a functional earthing terminal/conductor, it shall not be marked with an identification of a protective earthing terminal/conductor.
- The requirements for functional earthing are to be defined by the manufacturer or the relevant product committee and should be specified within the documentation of the equipment.

NOTE For example requirements for handling EMC issues.

6 Identification by colours

6.1 General

For identification of conductors, the following colours are permitted:

- black, brown, red, orange, yellow, green, blue, violet, grey, white, pink, turquoise.

NOTE This list of colours is derived from IEC 60757.

The identification by colour shall be used at terminations and preferably throughout the length of the conductor either by the colour of the insulation or by colour markers, except for bare conductors where the colour identification shall be at termination and connection points.

Identification by colour or marking is not required for

- concentric conductors of cables,

- metal sheath or armour of cables when used as a protective conductor,
- bare conductors where permanent identification is not practicable,
- extraneous-conductive-parts used as a protective conductor,
- exposed-conductive-parts used as a protective conductor.

Additional markings, for example alphanumerical, are allowed, provided that the colour identification remains unambiguous.

6.2 Use of single colours

6.2.1 Permitted colours

The single colours green and yellow are only permitted where confusion with the colouring of the conductors in accordance with 6.3.2 to 6.3.6 is not likely to occur.

6.2.2 Neutral or mid-point conductors

Where a circuit includes a neutral or mid-point conductor identified by colour, the colour used for this purpose shall be blue. In order to avoid confusion with other colours it is recommended to use an unsaturated colour blue, often called "light blue". Blue shall not be used for identifying any other conductor where confusion is possible.

In the absence of a neutral or mid-point conductor within the whole wiring system, a conductor identified by blue may be used for any other purposes, except as a protective conductor.

If identification by colour is used, bare conductors used as neutral or mid-point conductors shall be either coloured by a blue stripe, 15 mm to 100 mm wide in each unit or enclosure and each accessible position, or coloured blue throughout their length.

NOTE IEC 60079-11 prescribes blue when a colour is used for the marking of terminal, terminal boxes, plugs and sockets of intrinsically-safe circuits.

6.2.3 Line conductors in AC-systems

For line conductors in AC-systems the preferred colours are BLACK, BROWN and GREY.

NOTE Sequence of colour codes in this clause is alphabetical. It does not recommend phasing or direction of rotation.

6.3 Use of bi-colour combinations

6.3.1 Permitted colours

Combinations of any two of the colours listed in 6.1 are permitted provided there is no risk of confusion.

To avoid such confusion the colour green and the colour yellow shall not be used in colour combinations other than the combination green-and-yellow. The use of the combination of the colours green-and-yellow is restricted to the purposes of 6.3.2 to 6.3.6.

6.3.2 Protective conductors

Protective conductors shall be identified by the bi-colour combination green-and-yellow.


NOTE 1 It may be necessary to provide additional marking to unambiguously identify a certain designated conductor.

NOTE 2 An additional colour marking is required for PEN, PEL and PEM conductors.

Green-and-yellow is the only colour combination recognized for identifying the protective conductor.

The colour combination green-and-yellow shall be such that, on any 15 mm length of the conductor where colour coding is applied, one of these colours covers at least 30 % and not more than 70 % of the surface of the conductor, the other colour covering the remainder of that surface.

If bare conductors, used as protective conductors, are provided with colouring they shall be coloured green-and-yellow, either throughout the whole length of each conductor or in each compartment or unit or at each accessible position. If adhesive tape is used, only bi-coloured tape shall be applied.

NOTE 3 Where the protective conductor can be easily identified by its shape, construction or position, for example a concentric conductor, colour coding throughout its length is not necessary but the ends or accessible positions should be clearly identified by the graphical symbol  or the bi-colour combination green-and-yellow or the alphanumeric notation PE.

NOTE 4 If extraneous conductive parts are used as a PE conductor identification by colours is not necessary.

6.3.3 PEN conductors

PEN conductors, when insulated, shall be marked by one of the following methods:

- green-and-yellow throughout their length with, in addition, blue markings at the terminations; or
- blue throughout their length with, in addition, green-and-yellow markings at the terminations.

NOTE 1 The choice of method or methods to be applied within a country should be made by the relevant committees and not on individual basis.

NOTE 2 The additional blue markings at the termination may be omitted once either of the following two indents is met:

- in electrical equipment, if relevant requirements are included in specific product standards or within a country;
- in case of wiring systems, for example those used in industry, if decided by the relevant committee.

6.3.4 PEL conductors

PEL conductors, when insulated, shall be marked green-and-yellow throughout their length with, in addition, blue markings at their terminations.

NOTE The additional blue markings at the termination may be omitted once either of the following two indents is met:

- in electrical equipment, if relevant requirements are included in specific product standards or within a country;
- in case of wiring systems, for example those used in industry, if decided by the relevant committee.

If confusion with a PEN or PEM conductor is likely, the alphanumeric designation as given in 7.3.5 shall be indicated at their terminations.

6.3.5 PEM conductors

PEM conductors, when insulated, shall be marked green-and-yellow throughout their length with, in addition, blue markings at their terminations.

NOTE The additional blue markings at the termination may be omitted once either of the following two indents is met:

- in electrical equipment, if relevant requirements are included in specific product standards or within a country;
- in case of wiring systems, for example those used in industry, if decided by the relevant committee.

If confusion with a PEN or PEL conductor is likely, the alphanumeric designation as given in 7.3.6 shall be indicated at their terminations.

6.3.6 Protective bonding conductors

Protective bonding conductors shall be identified by the bi-colour combination green-and-yellow as specified in 6.3.1.

7 Identification by alphanumeric notation

7.1 General

If letters and/or numerals are used for identification, letters shall be upper case Latin characters only and numerals shall be Arabic numerals.

NOTE It is recommended that the reference letters for DC elements be chosen from the first part and reference letters for AC elements from the second part of the alphabet.

Letters “I” and “O” shall not be used to prevent confusion with the numerals “1” and “0”; the signs “+” and “–” may be used.

In order to avoid confusion, unattached numerals 6 and 9 shall be underlined.

All alphanumeric notations shall be in strong contrast to the colour of the insulation.

The identification shall be clearly legible and durable.

NOTE For evaluation of the durability see IEC 60227-2.

The alphanumeric system applies to identification of conductors and of conductors in a group of conductors. Conductors with green-and-yellow coloured insulation shall only be identified as a certain designated conductor in accordance with 7.3.3 to 7.3.9.

The alphanumeric identifications specified in 7.3 shall not be used for any other purpose than that specified.

Where no confusion is possible, parts of the complete alphanumeric notation laid down in the following marking principles may be omitted.

7.2 Equipment terminal identification – Marking principles

Terminal marking is based on the following principles:

7.2.1 The two end points of an element are distinguished by consecutive reference numbers, the odd number being lower than the even number, for example 1 and 2 (see Figure 1).

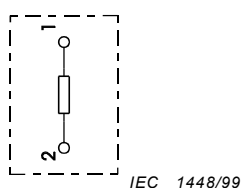


Figure 1 – Single element with two terminals