

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-machine, le marquage et l'identification – Identification des bornes de matériels, des extrémités de conducteurs et des conducteurs



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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 01.080.20; 13.110; 29.020

ISBN 978-2-8322-4577-4

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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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This document has been prepared by IEC technical committee 3: Information structures and elements, identification and marking principles, documentation and graphical symbols.

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

This sixth edition cancels and replaces the fifth edition of IEC 60445, published in 2010.

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

- a) the text of the introduction has been moved into the scope in accordance with IEC Guide 104;
- b) colour codes for the identification of line conductors of DC systems;
- c) colour code for the identification of functional earthing conductor;
- d) update of Table A.1 with colour codes for DC line conductors;

- e) conversion of notes containing non-mandatory requirements to normative text;
- f) the terminology is aligned with IEC 60050-195.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
3/1313/FDIS	3/1326/RVD

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

This document 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 document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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- withdrawn,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

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The contents of the corrigendum of November 2017 have been included in this copy.

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

1 Scope

This document 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.

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.

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2 Normative references

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The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

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

3.1**electric equipment**

item used for such purposes as generation, conversion, transmission, distribution or utilization of electric energy, such as electric machines, transformers, switchgear and controlgear, measuring instruments, protective devices, wiring systems, current-using equipment

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

3.2**functional bonding conductor**

conductor provided for functional-equipotential-bonding

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

3.3**functional earthing****functional grounding (US)**

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

[SOURCE: IEC 60050-195/AMD1:2001, 195-01-13]

3.4**functional earthing conductor****functional grounding conductor, US**

earthing conductor provided for functional earthing

[SOURCE: IEC 60050-195:1998, 195-02-15]

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3.5**functional-equipotential-bonding**

equipotential bonding for operational reasons other than safety

[SOURCE: IEC 60050-195:1998, 195-01-16]

3.6**line conductor**

DEPRECATED: phase conductor (in AC systems)

DEPRECATED: pole conductor (in DC systems)

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

[SOURCE: IEC 60050-195:1998, 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

[SOURCE: IEC 60050-195:1998, 195-02-07]

3.8**neutral conductor**

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

[SOURCE: IEC 60050-195:1998, 195-02-06]

3.9

PEL conductor

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

[SOURCE: IEC 60050-195:1998, 195-02-14]

3.10

PEM conductor

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

[SOURCE: IEC 60050-195:1998, 195-02-13]

3.11

PEN conductor

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

[SOURCE: IEC 60050-195:1998, 195-02-12]

3.12

protective bonding conductor

DEPRECATED: equipotential bonding conductor
protective conductor provided for protective-equipotential-bonding

[SOURCE: IEC 60050-195:1998, 195-02-10]

3.13

protective bonding conductor earthed

protective bonding conductor with a conductive path to local earth

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3.14

protective bonding conductor unearthed

protective bonding conductor without a conductive path to local earth

3.15

protective conductor

(identification: PE)

equipment grounding conductor, US

grounding electrode conductor, US

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

Note 1 to entry: The terms equipment grounding conductor and grounding electrode conductor are used in the US depending on their application.

[SOURCE: IEC 60050-195:1998, 195-02-09, modified – two synonyms and a note to entry have been added.]

3.16

protective earthing

protective grounding, US

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

[SOURCE: IEC 60050-195:2001, 195-01-11]

3.17**protective earthing conductor****protective grounding conductor, US**

protective conductor provided for protective earthing

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

3.18**protective-equipotential-bonding**

equipotential bonding for the purposes of safety

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

3.19

earth, verb

ground, verb, US

make an electric connection between a given point in a system of in an installation or in equipment and a local earth

Note 1 to entry: The connection to local earth may be
– intentional, or
– unintentional or accidental
and may be permanent or temporary.

[SOURCE: IEC 60050-195:1998, 195-01-08]

3.20**equipotential bonding**

provision of electric connections between conductive parts, intended to achieve equipotentiality

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[SOURCE: IEC 60050-195:1998, 195-01-10]

3.21**equipotentiality**

state when conductive parts are at a substantially equal electric potential

[SOURCE: IEC 60050-195:1998, 195-01-09]

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 are used 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 and conductors used for earthing are divided concerning their purpose of earthing into the two basic concepts 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 or protective earthing conductor, respectively.
- If the requirements for protective earthing are not met by a functional earthing terminal or functional earthing conductor, it shall not be marked with an identification of a protective earthing terminal or protective earthing conductor, respectively.
- 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 alphanumeric, 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 conductor

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 In IEC 60079-11, the colour BLUE is used for the marking by colour of terminals, terminal boxes, plugs and sockets of intrinsically-safe circuits.

6.2.3 Line conductor in AC system

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

NOTE The sequence of colour codes in 6.2.3 is alphabetical, and does not indicate any preferred phasing or direction of rotation.

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6.2.4 Line conductor in DC system

For line conductors in DC systems the preferred colours are:

- RED for the positive line conductor,
- WHITE for the negative line conductor.

6.2.5 Functional earthing conductor

For colour marking of a functional earthing conductor the preferred colour is PINK. The colour need only be applied at the terminations and at points of connection.

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 colour combination GREEN-AND-YELLOW is restricted to the purposes of 6.3.2 to 6.3.6.

6.3.2 Protective conductor


The protective conductor shall be identified by the bi-colour combination GREEN-AND-YELLOW.

GREEN-AND-YELLOW is the only colour combination recognized for identifying the protective conductor.

For a PEN, PEM, and PEL conductor, additional requirements are given in 6.3.3 to 6.3.5

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 GREEN-AND-YELLOW tape shall be applied.

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 IEC 60417-5019 (2006-08) "Protective earth; protective ground", , or the bi-colour combination GREEN-AND-YELLOW or the alphanumeric notation PE.

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

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6.3.3 PEN conductor

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

- GREEN-AND-YELLOW throughout its length with, in addition, BLUE markings at the terminations and points of connection; or
- BLUE throughout its length with, in addition, GREEN-AND-YELLOW markings at the terminations and points of connection.

The method to be applied within a country should be decided by the National Committee and not on an individual basis.

The additional BLUE markings at the termination and points of connection may be omitted once either of the following two conditions is met:

- in electric 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 conductor

A PEL conductor, when insulated, shall be marked GREEN-AND-YELLOW throughout its length with, in addition, BLUE markings at its terminations and points of connection of the PEL conductor.

The additional BLUE markings at the termination and points of connection may be omitted once either of the following two conditions is met:

- in electric 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 and points of connection.

6.3.5 PEM conductor

A PEM conductor, when insulated, shall be marked GREEN-AND-YELLOW throughout its length with, in addition, BLUE markings at its terminations and points of connection of the PEM conductor.

The additional BLUE markings at the termination and points of connection may be omitted once either of the following two conditions is met:

- in electric 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 conductor

A protective bonding conductor shall be identified by the bi-colour combination GREEN-AND-YELLOW as specified in 6.3.1.

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7 Identification by alphanumeric notation

7.1 General

IEC 60445:2017

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

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 for identification to prevent confusion with the numerals “1” and “0”; the alphanumeric 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 alphanumeric 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.