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BASIC SAFETY PUBLICATION

Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors (<https://standards.iteh.ai>)

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IEC 60445:2021

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IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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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**

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IEC 60445 has been prepared by IEC technical committee 3: Documentation, graphical symbols and representations of technical information. It is an International Standard.

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

This seventh edition cancels and replaces the sixth edition published in 2017. This edition constitutes a technical revision.

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

- a) the definitions have been aligned with IEC 60050-195:2021 and IEC 60050-826:—¹;
- b) the provisions for colour to be used for identification of certain designated conductors are made requirements and not only recommendations;
- c) introduction of a new subclause on marking of protective terminals for multiple power supply inputs on equipment.

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

FDIS	Report on voting
3/1491/FDIS	3/1517/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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.

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.

¹ Third edition under preparation. Stage at time of publication: IEC FDIS 60050-826:2021.

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 it 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~~ and alphanumeric notations are intended to be applied on cores, busbars, and electrical equipment, and in cables or installations.

This basic safety publication **focusing on safety essential requirements** 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.

2 Normative references

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* (available at <http://www.graphical-symbols.info/equipment>)

IEC 60617, *Graphical symbols for diagrams* (available at <http://std.iec.ch/iec60617>)

~~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

earthing

grounding, US

electric connections between conductive parts and local earth

[SOURCE: IEC 60050-195:2021, 195-01-24]

3.2

earthed protective bonding conductor ~~earthed~~

protective bonding conductor which has a conductive path to local earth

3.3

electrical equipment

item used for ~~such purposes as~~ generation, conversion, transmission, distribution or utilization of electric energy

Note 1 to entry: Examples of such items are electric machines, transformers, switchgear and controlgear, measuring instruments, protective devices, wiring systems, current-using equipment.

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

3.4

electrical safety

freedom from risk that is not tolerable and which is caused by electricity

[SOURCE: IEC 60050-195:2021, 195-01-20]

3.5

equipotential bonding

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

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[SOURCE: IEC 60050-195:~~1998~~2021, 195-01-10]

3.6

equipotentiality

state when conductive parts are at a substantially equal electric potential

[SOURCE: IEC 60050-195: ~~1998~~2021, 195-01-09]

3.7

functional bonding conductor

conductor provided for functional-equipotential-bonding

[SOURCE: IEC 60050-195:~~1998~~2021, 195-02-16]

3.8

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~~:2021, 195-01-13]

3.9**functional earthing conductor**
functional grounding conductor, US

~~earthing~~ conductor provided for functional earthing

[SOURCE: IEC 60050-195:~~1998~~2021, 195-02-15]

3.10**functional-equipotential-bonding**

equipotential bonding for ~~operational~~ reasons other than electrical safety

[SOURCE: IEC 60050-195:~~1998~~2021, 195-01-16]

3.11**line conductor**

~~DEPRECATED: phase conductor (in AC systems)~~

~~DEPRECATED: pole conductor (in DC systems)~~

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

[SOURCE: IEC 60050-195:~~1998~~2021, 195-02-08, modified – Note 1 to entry removed.]

3.12**local earth****local ground, US**

part of the Earth that is in electric contact with an earth electrode and that has an electric potential not necessarily equal to zero

[SOURCE: IEC 60050-195:2021, 195-01-03]

3.13**mid-point**

common point between two symmetrical circuit elements of which the opposite ends are electrically connected to different line conductors of the same circuit

[SOURCE: IEC 60050-195:2021, 195-02-04]

3.14**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~~2021, 195-02-07]

3.15**neutral conductor**

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

[SOURCE: IEC 60050-195:~~1998~~2021, 195-02-06]

3.16**neutral point**

common point of a star-connected polyphase system

[SOURCE: IEC 60050-195:2021, 195-02-05]

3.17**PEL conductor**

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

[SOURCE: IEC 60050-195:19982021, 195-02-14]

3.18**PEM conductor**

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

[SOURCE: IEC 60050-195:19982021, 195-02-13]

3.19**PEN conductor**

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

[SOURCE: IEC 60050-195:19982021, 195-02-12]

3.20**protective bonding conductor**

~~DEPRECATED: equipotential bonding conductor~~

protective conductor provided for protective-equipotential-bonding

[SOURCE: IEC 60050-195:19982021, 195-02-10]

3.21**protective conductor**

~~(identification: PE)~~

equipment grounding conductor, US

grounding electrode conductor, US

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

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

[SOURCE: IEC 60050-195:19982021, 195-02-09, modified – Two synonyms and Note 1 to entry have been added.]

3.22**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 60050-195:20012021, 195-01-11]

3.23**protective earthing conductor****PE conductor**

protective grounding conductor, US

protective conductor provided for protective earthing

[SOURCE: IEC 60050-195:19982021, 195-02-11]

3.24**protective-equipotential-bonding**

equipotential bonding for the purposes of electrical 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]

3.25**protective terminal**

terminal provided on equipment and intended for the electric connection with a protective conductor

[SOURCE: IEC 60050-195:2021, 195-02-43]

3.26**system-referencing-conductor**

conductor between a live conductor and the earthing arrangement to enable the live conductor to be substantially at the same potential as the Earth

[SOURCE: IEC 60050-826: —, 826-13-38]

3.27**terminal**

conductive part of electrical equipment provided for connecting that electrical equipment to one or more external conductors

[SOURCE: IEC 60050-151:2001, 151-12-12, modified – "device, electric circuit or electric network" is replaced by "electrical equipment", and Note 1 to entry is removed.]

3.28**unearthed protective bonding conductor**

protective bonding conductor ~~without a conductive path to local earth~~ which is isolated from the Earth

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 1 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.

NOTE 2 Annex A contains Table A.1 which provides an overview of identifications of certain designated conductors and equipment terminals to which these conductors are likely to be connected.

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 or equipotential bonding are divided ~~concerning~~ according to their purpose of earthing/bonding into the two basic concepts of protective ~~earthing~~ purposes and functional ~~earthing~~ purposes:

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

NOTE 1 For example, requirements for handling electromagnetic compatibility (EMC) issues.

NOTE 2 Annex A contains Table A.1 which provides an overview of identifications of certain designated conductors and equipment terminals to which these conductors are likely to be connected.

6 Identification by colours

6.1 General

For identification of conductors, ~~only~~ the following colours ~~are permitted~~ shall be used:

BLACK, BROWN, RED, ORANGE, GREEN, YELLOW, 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.

Where conductors shall be identified by colours, the requirements of 6.2 and 6.3 apply.

6.2 Use of single colours

6.2.1 ~~Permitted colours~~ The use of the single colours GREEN and YELLOW

The single colours GREEN and YELLOW ~~are~~ shall only ~~permitted~~ be used 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 shall be identified by the colour BLUE, ~~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".

Where a neutral or mid-point conductor is present, the colour 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~~ the colour BLUE may be used for identifying a conductor with any other purpose, 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 at 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 shall be identified by the ~~preferred~~ colours ~~are~~ BLACK, BROWN ~~and~~ or GREY.

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

6.2.4 Line conductor in DC system

~~For~~ Line conductors in DC systems shall be identified by the ~~preferred colours are~~ colour:

- 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 shall be identified by the ~~preferred~~ colour is PINK. ~~The colour need only be applied at the terminations and at points of connection~~. It is only necessary to apply the identification at the terminations and at points of connection.