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Edition 6.0 2017-08
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

BASIC SAFETY PUBLICATION

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

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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 redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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.

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

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.

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.

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

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*

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

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

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]

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

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~~, Amendment 1~~: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

[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 ~~may be needed~~ 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 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 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 ~~prescribes blue when a~~, 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 ~~recommend~~ indicate any preferred phasing or direction of rotation.

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 use of~~ The colour combination ~~of the colours~~ 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.

~~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.

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.

~~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 IEC 60417-5019 (2006-08) "Protective earth; protective ground",  , 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 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.

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

~~NOTE 2~~ The additional BLUE markings at the termination and points of connection may be omitted once either of the following two ~~indents~~ 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.

~~NOTE~~ The additional BLUE markings at the termination and points of connection may be omitted once either of the following two ~~indents~~ 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.

~~NOTE~~ The additional BLUE markings at the termination and points of connection may be omitted once either of the following two ~~indents~~ 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.

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 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.

7.2 Equipment terminal identification – Marking principles

7.2.1 Marking of equipment terminals is (or should be) based on the principles provided in 7.2.2 to 7.2.5:

7.2.2 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).

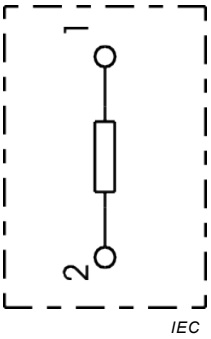


Figure 1 – Single element with two terminals

7.2.3 The intermediate points of a single element are distinguished by reference numbers, preferably in a numerical order, for example 3, 4, 5, etc. The reference numbers chosen for intermediate points shall be higher than those chosen for the end points; their numbering commences at the point which lies closest to the end point with the lower reference number. Thus, for example, the intermediate points, of an element with the end points 1 and 2 will be denoted by the reference numbers 3 and 4 (see Figure 2).

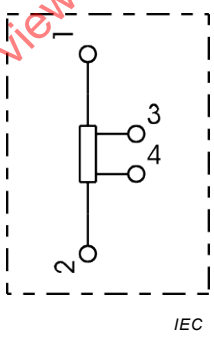


Figure 2 – Single element with four terminals: Two endpoints and two intermediate points

7.2.4 If several similar elements are combined in a group of elements, then one of the following methods for marking the elements shall be used:

– the two end points and intermediate points, if any, are distinguished by letters preceding the reference numbers referred to in 7.2.2 and 7.2.3, for example U, V, W corresponding to the phases of a three-phase AC system (see Figure 3);

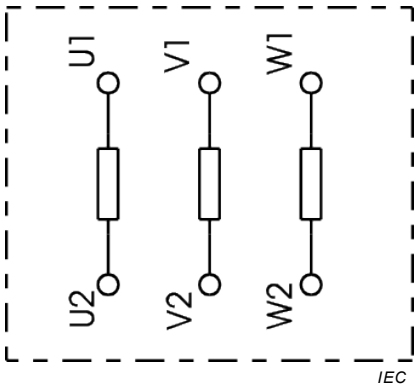


Figure 3 – Three-phase equipment with six terminals

– the two end points and intermediate points, if any, are distinguished by numbers preceding the reference numbers referred to in 7.2.2 and 7.2.3 where a phase identification is not necessary or possible. To avoid confusion these numbers shall be separated by a full stop. For example the end points of one element may be marked 1.1 and 1.2, those of another element 2.1 and 2.2 (see Figure 4);

NOTE For examples of an unambiguous terminal designation with respect to the object to which the terminal belongs, see IEC 61666:2010, Annex A.

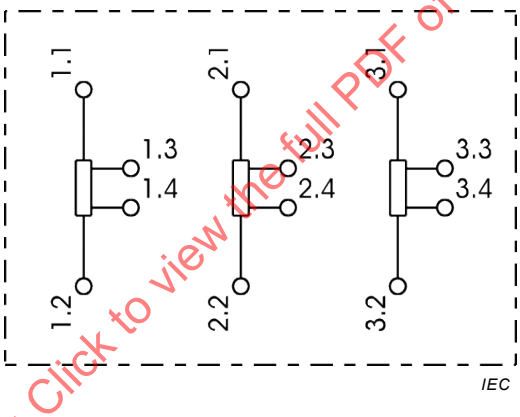
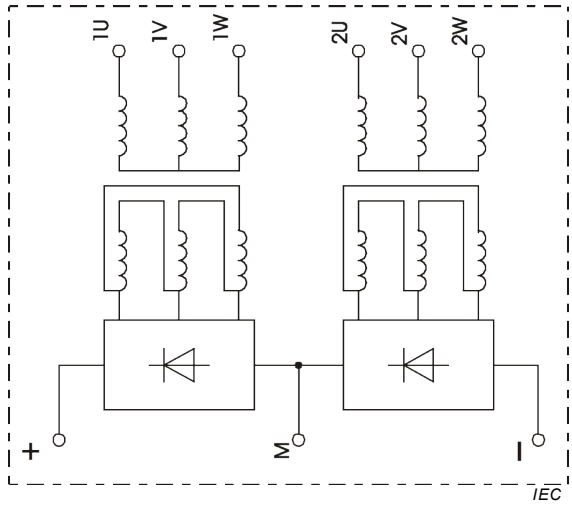


Figure 4 – Three-element equipment with twelve terminals: Six endpoints and six intermediate points

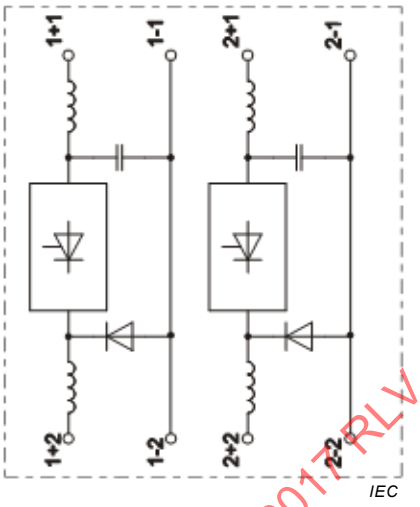
– in case of terminal blocks, numerical identification in numerical order.

Further detailed requirements on terminal markings and identification may be given by relevant product committees.

7.2.5 Similar groups of elements having the same reference letters are distinguished by a numerical prefix to the reference letters (see Figure 5a and Figure 5b)).



a) Three-phase equipment with two groups of elements



b) Two-phase equipment with two groups of elements with four terminals each not intended to be connected to certain designated conductors

Figure 5 – Equipment with groups of elements

Figure 6 illustrates the interconnection of equipment terminals and certain designated conductors, marked in accordance with the alphanumeric notation.

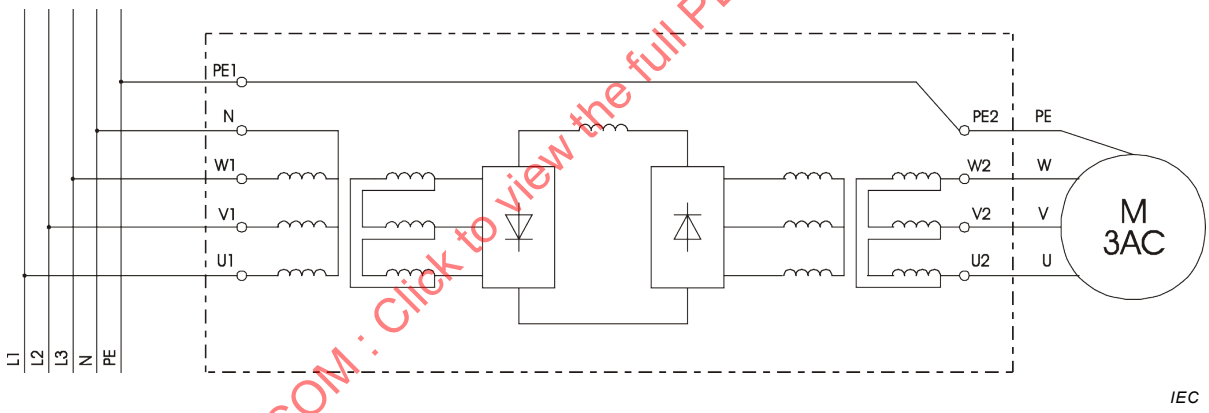


Figure 6 – Interconnection of equipment terminals and certain designated conductors

7.3 Identification of certain designated conductors

7.3.1 General

Equipment terminals which are intended to be connected directly or indirectly to certain designated conductors, and terminations of certain designated conductors shall be marked with reference letters or graphical symbols or both reference letters and graphical symbols according to Table A.1.

7.3.2 Neutral conductor

The alphanumeric identification of a neutral conductor shall be ‘N’.

7.3.3 Protective conductor

The alphanumeric identification of a protective conductor shall be ‘PE’. This identification also applies for a protective earthing conductor.

7.3.4 PEN conductor

The alphanumeric identification of a PEN conductor shall be ‘PEN’.

7.3.5 PEL conductor

The alphanumeric identification of a PEL conductor shall be ‘PEL’.

7.3.6 PEM conductor

The alphanumeric identification of a PEM conductor shall be ‘PEM’.

7.3.7 Protective bonding conductor

The alphanumeric identification of a protective bonding conductor shall be ‘PB’.

7.3.8 Protective bonding conductor earthed

If it is necessary to distinguish between a protective bonding conductor earthed and a protective bonding conductor unearthed, the alphanumeric identification of a protective bonding conductor earthed shall be ‘PBE’.

7.3.9 Protective bonding conductor unearthed

If it is necessary to distinguish between a protective bonding conductor earthed and a protective bonding conductor unearthed, the alphanumeric identification of a protective bonding conductor unearthed shall be ‘PBU’.

7.3.10 Functional earthing conductor

The alphanumeric identification of a functional earthing conductor shall be ‘FE’.

7.3.11 Functional bonding conductor

The alphanumeric identification of a functional bonding conductor shall be ‘FB’.

7.3.12 Mid-point conductor

The alphanumeric identification of a mid-point conductor shall be ‘M’.

7.3.13 Line conductor

The alphanumeric identification of a line conductor shall start with the letter “L” suffixed by:

– for an AC circuit, a sequential number of line conductors, starting with the digit one “1”;
– for a DC circuit, with the sign “+” for the positive line conductor and with the sign “-“ for the negative line conductor.

If no more than one line conductor is used, the suffix may be omitted.

Annex A
(informative)

Colours, alphanumeric notations and graphical symbols used for identification of conductors and terminals

Table A.1 – Colours, alphanumeric notations and graphical symbols used for identification of conductors and terminals

Designated conductors/terminals		Identification of conductors / terminals by				
		Alphanumeric notations [a]		Colours		Graphical symbols [b]
		Conductors	Terminals			
AC conductors		AC	AC	-		
	Line 1	L1	U		BK [d] or	
	Line 2	L2 [c]	V		BN [d] or	
	Line 3	L3 [c]	W		GY [d]	
	Mid-point conductor	M	M		BU [e]	No recommendation
	Neutral conductor	N	N			
DC conductors		DC	DC	-		
	Positive	L+	+		RD	
	Negative	L-	-		WH	
	Mid-point conductor	M	M		BU [e]	No recommendation
	Neutral conductor	N	N			
Protective conductor		PE	PE		GNYE	
	PEN conductor	PEN	PEN		GNYE [f]	No recommendation
	PEL conductor	PEL	PEL			
	PEM conductor	PEM	PEM		BU [f]	
Protective bonding conductor [g]		PB	PB		GNYE	
	– earthed	PBE	PBE			No recommendation
	– unearthed	PBU	PBU			
Functional earthing conductor [h]		FE	FE		PK	
Functional bonding conductor		FB	FB	No recommendation		

[a] See Clause 7.

[b] The graphics shown correspond to the following symbol No in IEC 60417.

	IEC 60417-5032 (2002-10)		IEC 60417-5019 (2006-08)
	IEC 60417-5031 (2002-10)		IEC 60417-5018 (2006-10)
	IEC 60417-5005 (2002-10)		IEC 60417-5020 (2002-10)
	IEC 60417-5006 (2002-10)		IEC 60417-5021 (2002-10)

[c] Only necessary in systems with more than one phase.

[d] This sequence of colour codes is alphabetical. It does not represent recommended phasing or a direction of rotation.

[e] See 6.2.2.

[f] See 6.3.3 to 6.3.5.

[g] A protective bonding conductor will in most cases be a protective bonding conductor earthed. It is not necessary to designate it with PBE. In those cases where a distinction between a protective bonding conductor earthed and a protective bonding conductor unearthed is used, a clear distinction between them shall be made (for example, within electro-medical installations) and the designations PBE and PBU should be applied.

[h] Neither the designation FE nor the graphical symbol 5018 of IEC 60417 shall be applied for conductors or terminals having a protective function. Bi-colour insulation GREEN-AND-YELLOW cannot be used for conductors that do not have a protective function (i.e. for conductors other than PE, PEN, PEL, PEM, PB, PBE, PBU). See Clause 5.

Annex B
(informative)

List of notes concerning certain countries

Country	Clause/subclause No.	Nature (permanent or less permanent according to IEC Directives)	Rationale (detailed justification for the requested country note)	Wording
RU	3		The earthed line conductor is used in single-phase AC electrical systems, in three-phase AC electrical systems without the neutral point and in two-wire DC electrical systems. In the Russian Federation ~~use of~~ terms "phase conductor" and “pole conductor” ~~has been renewed tom indicate~~ are used for the identification of line conductors in AC systems and DC systems respectively.	In the Russian Federation, the following definitions apply: **earthed line conductor** line conductor which has an electrical connection with the earth electrode **phase conductor** line conductor which is used in an AC electrical circuit **pole conductor** line conductor which is used in an DC electrical circuit
RU	3.1			In the Russian Federation, the term “electric equipment” is defined differently: **electric equipment** item intended for generation, transmission and variation of characteristics of an electric energy, and also for convert electric energy into another form of energy
RU	3.3			In the Russian Federation, the term “functional earthing” is defined differently: **functional earthing** earthing for functional purposes other than electrical safety
RU	3.5			In the Russian Federation, the term “functional earthing” is defined differently: **functional-equipotential-bonding** equipotential bonding for operational reasons other than electrical safety

Country	Clause/subclause No.	Nature (permanent or less permanent according to IEC Directives)	Rationale (detailed justification for the requested country note)	Wording
RU	3.6		The term "**normal conditions**" is used in the fundamental rule of protection against electric shock (see IEC 61140:2016, Clause 4). Therefore, it should be used in definitions.	In the Russian Federation, the term "line conductor" is defined differently: conductor which is energized under normal conditions and used for the transmission of electric energy but which is not a neutral conductor or a mid-point conductor
RU	3.7		The definition of the term "mid-point conductor" in IEC 60050-195 is given so that the area of use of this conductor is uncertain. In the Russian Federation the definition of the mid-point conductor taken from IEC 60050-195 has been executed more precisely to state unambiguously its application in the DC electrical circuits.	In the Russian Federation, the term "mid-point conductor" is defined ~~as~~ differently: **mid-point conductor** conductor electrically connected to the mid-point of the DC electrical system and used for the transmission ~~and distribution~~ of electric energy
RU	3.8		The definition of the term "neutral conductor" in IEC 60050-195 is given so that the area of use of this conductor is uncertain. In the Russian Federation the definition of the neutral conductor taken from IEC 60050-195 has been executed more precisely to state unambiguously its application in the AC electrical circuits.	In the Russian Federation, the term "neutral conductor" is defined ~~as~~ differently: **neutral conductor** conductor electrically connected to the neutral point or the mid-point of the AC electrical system and used for the transmission ~~and distribution~~ of electric energy
US	3.8		In the United States, while the term "neutral conductor" is used, this conductor is often also or alternatively identified as "grounded conductor".	In the United States identification of the terminal for connection of the grounded conductor is by a white colour, or by the word "white" or the letter "W" adjacent to the terminal."
RU	3.15			In the Russian Federation, the term "protective conductor" is defined differently: **protective conductor** (identification PE) **conductor provided for the purposes of electrical safety, for example protection against electric shock**
RU	3.16			In the Russian Federation, the term "protective earthing" is defined differently: **protective earthing** earthing for the purposes of electrical safety

Country	Clause/subclause No.	Nature (permanent or less permanent according to IEC Directives)	Rationale (detailed justification for the requested country note)	Wording
RU	3.18			In the Russian Federation, the term “protective-equipotential-bonding” is defined differently: **protective-equipotential-bonding** equipotential bonding for the purposes of electrical safety
~~RU~~	~~6.2~~			~~In the Russian Federation, the preferred colour of the phase conductor of a single-phase electrical circuit is BROWN. When the single-phase electrical circuit is branched from a three-phase electrical circuit, the colour identification of the phase conductor of the single-phase electrical circuit should coincide with the colour identification of that phase conductor of the three-phase electrical circuit to which it is connected electrically.~~
~~RU~~	~~6.2~~			~~In the Russian Federation, the preferred colour of the positive pole conductor is BROWN, the preferred colour of the negative pole conductor is GREY. When the two-wire d.c. electrical circuit is branched from a 3-wire d.c. electrical circuit, the colour identification of the pole conductor of the two-wire electrical circuit should coincide with the colour identification of that pole conductor of the 3-wire electrical circuit to which it is connected electrically.~~ ~~In the Russian Federation, the preferred colour of the earthed pole conductor is BLUE. If confusion with the neutral conductor, the mid-point conductor or the earthed phase conductor is likely, the alphanumeric designation shall be indicated at the terminations of the earthed pole conductors and in points of their connections.~~
RU	6.2.1			In the Russian Federation, it is not permitted to use separately the GREEN colour and YELLOW colour for identification of conductors.
US	6.2.1			In the United States, the use of the single colour GREEN is permitted for identification of protective earth conductors.
CA	6.2.2			In Canada, the colour identification WHITE or NATURAL GREY for the mid-point or neutral conductor is used as a replacement for the colour identification BLUE.
JP	6.2.2			In Japan, the colour identification WHITE or NATURAL GREY for the mid-point or neutral conductor is used as a replacement for the colour identification BLUE.
~~RU~~	~~6.2.2~~			~~In the Russian Federation, it is permitted to use BLUE colour for identification of the neutral conductors, the mid-point conductors and the earthed line conductors.~~

Country	Clause/subclause No.	Nature (permanent or less permanent according to IEC Directives)	Rationale (detailed justification for the requested country note)	Wording
RU	6.2.2			In the Russian Federation, the BLUE colour should be used only for identification of the neutral conductors, the mid-point conductors and the earthed line conductors.
US	6.2.2			In the United States, the colour identification WHITE or NATURAL GREY for the mid-point or neutral conductor is used as a replacement for the colour identification BLUE.
US	6.2.2			In the United States, the use of the colour BLUE is permitted for phase conductors. Neutral conductors are permitted to be WHITE, GREY or with three WHITE stripes on insulation other than GREEN.
AU	6.2.3			In Australia, the colour BLACK shall not be used for identification of line conductors of installation wiring. The colour BROWN is acceptable for a single-phase line conductor and BROWN, BROWN and BROWN is acceptable for line conductors L1, L2 and L3.
CA	6.2.3			In Canada, where the colour GREY is used as a replacement for the colour identification BLUE for neutral or mid-point conductor, the colour GREY shall not be used for identification of line conductors in AC systems if confusion is likely.
CA	6.2.3			In Canada, the colour GREY can be applied as identification of the neutral or mid-point conductor; the colour GREY shall not be used for any other purpose than that specified in the Note of this subclause.
JP	6.2.3			In Japan, where the colour GREY is used as a replacement for the colour identification BLUE for the neutral or mid-point conductor, the colour GREY shall not be used for identification of line conductors in AC-systems if confusion is likely.
JP	6.2.3			In Japan, the colour GREY can be applied as identification of the neutral or mid-point conductor; the colour GREY shall not be used for any other purpose than specified in the Note of this subclause.
RU	6.2.3			In the Russian Federation, the preferred colour of the phase conductor of a single-phase electrical circuit is BROWN. When the single-phase electrical circuit is branched from a three-phase electrical circuit, the colour identification of the phase conductor of the single-phase electrical circuit should coincide with the colour identification of that phase conductor of the three-phase electrical circuit to which it is connected electrically.

Country	Clause/subclause No.	Nature (permanent or less permanent according to IEC Directives)	Rationale (detailed justification for the requested country note)	Wording
RU	6.2.3			In the Russian Federation, the preferred colour of the earthed phase conductor is BLUE. If confusion with the neutral conductor, the mid-point conductor or the earthed pole conductor is likely, the alphanumeric designation shall be indicated at the terminations of the earthed phase conductors and in points of their connections.
US	6.2.3			In the United States, where the colour GREY is used as a replacement for the colour identification BLUE for the neutral or mid-point conductor, the colour GREY shall not be used for identification of line conductors in AC systems if confusion is likely.
US	6.2.3			In the United States, the colour GREY can be applied as identification of neutral or mid-point conductor, the colour GREY shall not be used for any other purpose than specified in Note 1 of this subclause.
RU	6.2.4			In the Russian Federation, the preferred colour of the earthed pole conductor is BLUE. If confusion with the neutral conductor, the mid-point conductor or the earthed phase conductor is likely, the alphanumeric designation shall be indicated at the terminations of the earthed pole conductors and in points of their connections.
CA	6.3.2			In Canada, the colour identification GREEN for the protective conductor is used as a replacement for the colour combination GREEN-AND-YELLOW.
JP	6.3.2			In Japan, the colour identification GREEN for the protective conductor is used as a replacement for the colour combination GREEN-AND-YELLOW.
US	6.3.2			In the United States, the colour identification GREEN for the protective conductor is used as a replacement for the colour combination GREEN-AND-YELLOW.
US	6.3.2			In the United States, the use of the single colour GREEN is permitted for identification of protective earth conductors.
US	7.3.2		In the United States, identification of the terminal for the grounded conductor is by coloration.	In the US identification of the terminal for connection of the grounded conductor is by a white colour, or by the word “white” or the letter “W” adjacent to the terminal.
US	7.3.3		In the United States, identification of the equipment grounding conductor is only by coloration of green or green with yellow stripes.	In the US, identification of the equipment grounding conductor is made by GREEN or GREEN with one or more YELLOW stripes for the insulation , other means of coloration, coloured tape or adhesive labels, or stripping the insulation or covering from the entire exposed length of the conductor.

Country	Clause/subclause No.	Nature (permanent or less permanent according to IEC Directives)	Rationale (detailed justification for the requested country note)	Wording
RU	7.3.13			In the Russian Federation, the alphanumeric identification of the phase conductor of a single-phase electrical circuit shall be "L". The alphanumeric identification of the phase conductors of a three-phase electrical circuit shall be "L1", "L2" and "L3". When the single-phase electrical circuit is branched from a three-phase electrical circuit, the alphanumeric identification of the phase conductor of the single-phase electrical circuit should coincide with the alphanumeric identification of that phase conductor of the three-phase electrical circuit to which it is connected electrically.
RU	7.3.13			In the Russian Federation, the alphanumeric identification of the positive pole conductor shall be "L+", and of the negative pole conductor shall be "L–". When the two-wire DC electrical circuit is branched from a three-wire DC electrical circuit, the alphanumeric identification of the pole conductor of the two-wire electrical circuit should coincide with the alphanumeric identification of that pole conductor of the three-wire electrical circuit to which it is connected electrically.
RU	7.3.13			In the Russian Federation, the alphanumeric identification of the earthed phase conductor of a single-phase electrical circuit shall be "LE", and of a three-phase electrical circuit shall be "LE1", "LE2" or "LE3". The alphanumeric identification of the earthed positive pole conductor shall be "LE+", the earthed negative pole conductor shall be "LE–".
AU	Table A.1			In Australia, the colour PINK is the preferred colour for identification of a functional earthing conductor ('FE'), but the colour WHITE is also accepted.
US	Table A.1		Identification of the terminal for equipment grounding conductors, grounding electrode conductors and bonding conductors is not as indicated.	In the US, identification of the terminal for connection of the equipment grounding conductor, grounding electrode conductor or bonding conductors shall be by one of the following: a. Green, not readily removable terminal screw with hexagonal head. b. Green, not readily removable and hexagonal terminal nut. c. Green pressure wire connector. d. If the terminal is not readily visible, marking of the word "green" or "ground", the letters "G" or "GR", a grounding symbol or identification by green colour. [see NFPA 70 National Electrical Code for additional information]

Bibliography

IEC 60050-195:1998, *International Electrotechnical Vocabulary (IEV) – Part 195: Earthing and protection against electric shock*
IEC 60050-195:1998/AMD1:2001

IEC 60050-826:2004, *International Electrotechnical Vocabulary (IEV) – Part 826: Electrical installations*

IEC 60079-11:2006, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"*

IEC 60227-2:1997, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750V – Part 2: Test methods*

IEC 60601 (all parts), *Medical electrical equipment*

IEC 60757:1983, *Code for designation of colours*

IEC 61140:2016, *Protection against electric shock – Common aspects for installations and equipment*

IEC 61666:~~1997~~ 2010, *Industrial systems, installations and equipment and industrial products – Identification of terminals within a system*

IEC 62491:2008, *Industrial systems, installations and equipment and industrial products – Labelling of cables and cores*

NFPA 70, *National Electrical Code*

IEC 60445

Edition 6.0 2017-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

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

IEC 60445:2017-08(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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.

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

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.

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.

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*

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]

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

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

[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 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 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.

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.

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.

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.

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.

7.2 Equipment terminal identification – Marking principles

7.2.1 Marking of equipment terminals is (or should be) based on the principles provided in 7.2.2 to 7.2.5:

7.2.2 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).

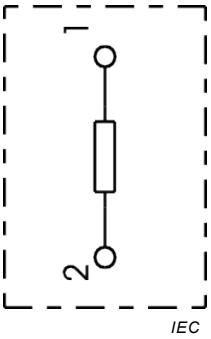


Figure 1 – Single element with two terminals

7.2.3 The intermediate points of a single element are distinguished by reference numbers, preferably in a numerical order, for example 3, 4, 5, etc. The reference numbers chosen for intermediate points shall be higher than those chosen for the end points; their numbering commences at the point which lies closest to the end point with the lower reference number. Thus, for example, the intermediate points, of an element with the end points 1 and 2 will be denoted by the reference numbers 3 and 4 (see Figure 2).

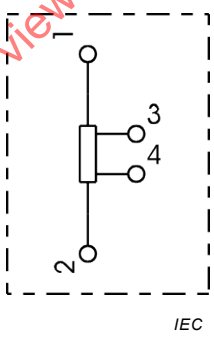


Figure 2 – Single element with four terminals: Two endpoints and two intermediate points

7.2.4 If several similar elements are combined in a group of elements, then one of the following methods for marking the elements shall be used:

– the two end points and intermediate points, if any, are distinguished by letters preceding the reference numbers referred to in 7.2.2 and 7.2.3, for example U, V, W corresponding to the phases of a three-phase AC system (see Figure 3);

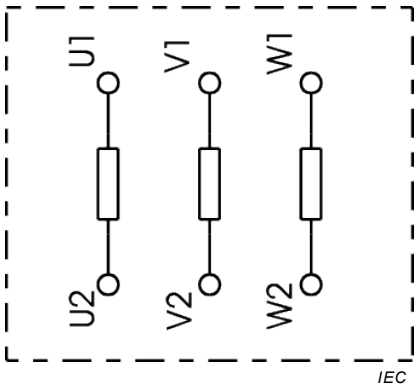


Figure 3 – Three-phase equipment with six terminals

– the two end points and intermediate points, if any, are distinguished by numbers preceding the reference numbers referred to in 7.2.2 and 7.2.3 where a phase identification is not necessary or possible. To avoid confusion these numbers shall be separated by a full stop. For example the end points of one element may be marked 1.1 and 1.2, those of another element 2.1 and 2.2 (see Figure 4);

NOTE For examples of an unambiguous terminal designation with respect to the object to which the terminal belongs, see IEC 61666:2010, Annex A.

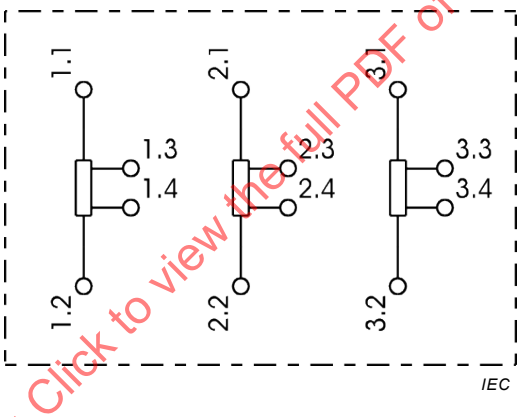
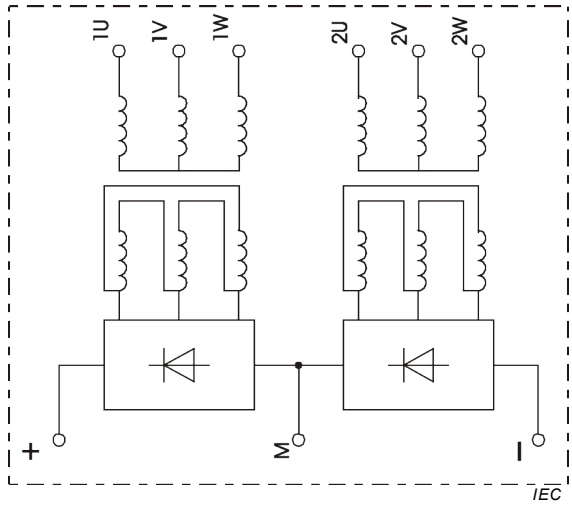


Figure 4 – Three-element equipment with twelve terminals: Six endpoints and six intermediate points

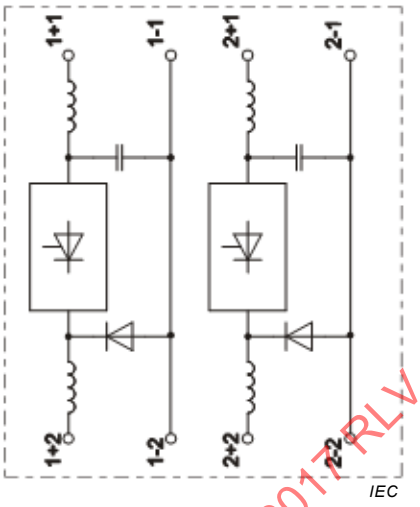
– in case of terminal blocks, numerical identification in numerical order.

Further detailed requirements on terminal markings and identification may be given by relevant product committees.

7.2.5 Similar groups of elements having the same reference letters are distinguished by a numerical prefix to the reference letters (see Figure 5a and Figure 5b)).



a) Three-phase equipment with two groups of elements



b) Two-phase equipment with two groups of elements with four terminals each not intended to be connected to certain designated conductors

Figure 5 – Equipment with groups of elements

Figure 6 illustrates the interconnection of equipment terminals and certain designated conductors, marked in accordance with the alphanumeric notation.

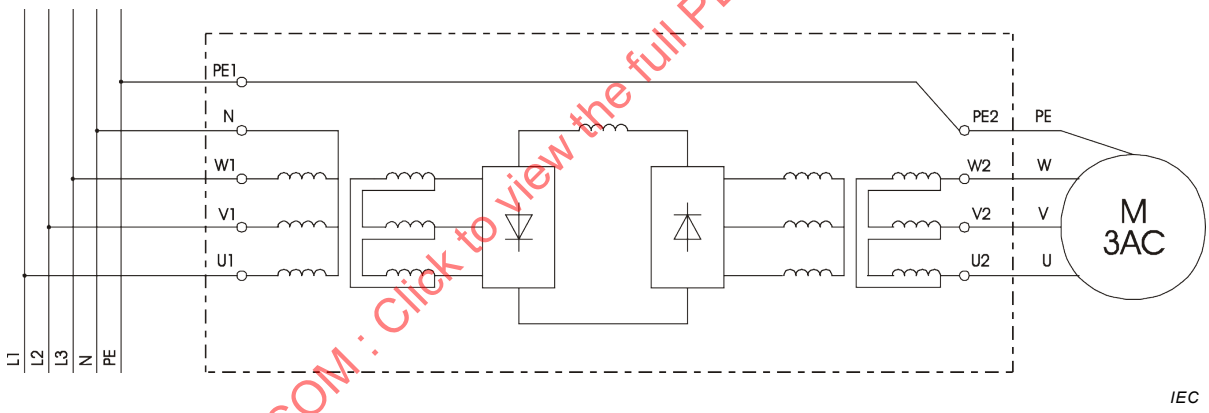


Figure 6 – Interconnection of equipment terminals and certain designated conductors

7.3 Identification of certain designated conductors

7.3.1 General

Equipment terminals which are intended to be connected directly or indirectly to certain designated conductors, and terminations of certain designated conductors shall be marked with reference letters or graphical symbols or both reference letters and graphical symbols according to Table A.1.

7.3.2 Neutral conductor

The alphanumeric identification of a neutral conductor shall be ‘N’.

7.3.3 Protective conductor

The alphanumeric identification of a protective conductor shall be ‘PE’. This identification also applies for a protective earthing conductor.

7.3.4 PEN conductor

The alphanumeric identification of a PEN conductor shall be ‘PEN’.

7.3.5 PEL conductor

The alphanumeric identification of a PEL conductor shall be ‘PEL’.

7.3.6 PEM conductor

The alphanumeric identification of a PEM conductor shall be ‘PEM’.

7.3.7 Protective bonding conductor

The alphanumeric identification of a protective bonding conductor shall be ‘PB’.

7.3.8 Protective bonding conductor earthed

If it is necessary to distinguish between a protective bonding conductor earthed and a protective bonding conductor unearthed, the alphanumeric identification of a protective bonding conductor earthed shall be ‘PBE’.

7.3.9 Protective bonding conductor unearthed

If it is necessary to distinguish between a protective bonding conductor earthed and a protective bonding conductor unearthed, the alphanumeric identification of a protective bonding conductor unearthed shall be ‘PBU’.

7.3.10 Functional earthing conductor

The alphanumeric identification of a functional earthing conductor shall be ‘FE’.

7.3.11 Functional bonding conductor

The alphanumeric identification of a functional bonding conductor shall be ‘FB’.

7.3.12 Mid-point conductor

The alphanumeric identification of a mid-point conductor shall be ‘M’.

7.3.13 Line conductor

The alphanumeric identification of a line conductor shall start with the letter “L” suffixed by:

– for an AC circuit, a sequential number of line conductors, starting with the digit one “1”;
– for a DC circuit, with the sign “+” for the positive line conductor and with the sign “-“ for the negative line conductor.

If no more than one line conductor is used, the suffix may be omitted.

Annex A
(informative)

Colours, alphanumeric notations and graphical symbols used for identification of conductors and terminals

Table A.1 – Colours, alphanumeric notations and graphical symbols used for identification of conductors and terminals

Designated conductors/terminals		Identification of conductors / terminals by				
		Alphanumeric notations [a]		Colours		Graphical symbols [b]
		Conductors	Terminals			
AC conductors		AC	AC	-		
	Line 1	L1	U	●	BK [d] or	
	Line 2	L2 [c]	V	●	BN [d] or	
	Line 3	L3 [c]	W	●	GY [d]	
	Mid-point conductor	M	M	●	BU [e]	No recommendation
	Neutral conductor	N	N			
DC conductors		DC	DC	-		
	Positive	L+	+	●	RD	
	Negative	L-	-	○	WH	
	Mid-point conductor	M	M	●	BU [e]	No recommendation
	Neutral conductor	N	N			
Protective conductor		PE	PE	▨	GNYE	
	PEN conductor	PEN	PEN	▨	GNYE [f]	No recommendation
	PEL conductor	PEL	PEL			
	PEM conductor	PEM	PEM	●	BU [f]	
Protective bonding conductor [g]		PB	PB	▨	GNYE	
	– earthed	PBE	PBE			No recommendation
	– unearthed	PBU	PBU			
Functional earthing conductor [h]		FE	FE	●	PK	
Functional bonding conductor		FB	FB	No recommendation		

[a] See Clause 7.

[b] The graphics shown correspond to the following symbol No in IEC 60417.

	IEC 60417-5032 (2002-10)		IEC 60417-5019 (2006-08)
	IEC 60417-5031 (2002-10)		IEC 60417-5018 (2006-10)
	IEC 60417-5005 (2002-10)		IEC 60417-5020 (2002-10)
	IEC 60417-5006 (2002-10)		IEC 60417-5021 (2002-10)

[c] Only necessary in systems with more than one phase.

[d] This sequence of colour codes is alphabetical. It does not represent recommended phasing or a direction of rotation.

[e] See 6.2.2.

[f] See 6.3.3 to 6.3.5.

[g] A protective bonding conductor will in most cases be a protective bonding conductor earthed. It is not necessary to designate it with PBE. In those cases where a distinction between a protective bonding conductor earthed and a protective bonding conductor unearthed is used, a clear distinction between them shall be made (for example, within electro-medical installations) and the designations PBE and PBU should be applied.

[h] Neither the designation FE nor the graphical symbol 5018 of IEC 60417 shall be applied for conductors or terminals having a protective function. Bi-colour insulation GREEN-AND-YELLOW cannot be used for conductors that do not have a protective function (i.e. for conductors other than PE, PEN, PEL, PEM, PB, PBE, PBU). See Clause 5.

Annex B
(informative)

List of notes concerning certain countries

Country	Clause/subclause No.	Nature (permanent or less permanent according to IEC Directives)	Rationale (detailed justification for the requested country note)	Wording
RU	3		The earthed line conductor is used in single-phase AC electrical systems, in three-phase AC electrical systems without the neutral point and in two-wire DC electrical systems. In the Russian Federation terms "phase conductor" and "pole conductor" are used for the identification of line conductors in AC systems and DC systems respectively.	In the Russian Federation, the following definitions apply: **earthed line conductor** line conductor which has an electrical connection with the earth electrode **phase conductor** line conductor which is used in an AC electrical circuit **pole conductor** line conductor which is used in an DC electrical circuit
RU	3.1			In the Russian Federation, the term "electric equipment" is defined differently: **electric equipment** item intended for generation, transmission and variation of characteristics of an electric energy, and also for convert electric energy into another form of energy
RU	3.3			In the Russian Federation, the term "functional earthing" is defined differently: **functional earthing** earthing for functional purposes other than electrical safety
RU	3.5			In the Russian Federation, the term "functional earthing" is defined differently: **functional-equipotential-bonding** equipotential bonding for operational reasons other than electrical safety

Country	Clause/subclause No.	Nature (permanent or less permanent according to IEC Directives)	Rationale (detailed justification for the requested country note)	Wording
RU	3.6		The term “**normal conditions**” is used in the fundamental rule of protection against electric shock (see IEC 61140:2016, Clause 4). Therefore, it should be used in definitions.	In the Russian Federation, the term “line conductor” is defined differently: conductor which is energized under normal conditions and used for the transmission of electric energy but which is not a neutral conductor or a mid-point conductor
RU	3.7		The definition of the term "mid-point conductor" in IEC 60050-195 is given so that the area of use of this conductor is uncertain. In the Russian Federation the definition of the mid-point conductor taken from IEC 60050-195 has been executed more precisely to state unambiguously its application in the DC electrical circuits.	In the Russian Federation, the term “mid-point conductor” is defined differently: **mid-point conductor** conductor electrically connected to the mid-point of the DC electrical system and used for the transmission of electric energy
RU	3.8		The definition of the term "neutral conductor" in IEC 60050-195 is given so that the area of use of this conductor is uncertain. In the Russian Federation the definition of the neutral conductor taken from IEC 60050-195 has been executed more precisely to state unambiguously its application in the AC electrical circuits.	In the Russian Federation, the term “neutral conductor” is defined differently: **neutral conductor** conductor electrically connected to the neutral point or the mid-point of the AC electrical system and used for the transmission of electric energy
US	3.8		In the United States, while the term “neutral conductor” is used, this conductor is often also or alternatively identified as “grounded conductor”.	In the United States identification of the terminal for connection of the grounded conductor is by a white colour, or by the word “white” or the letter “W” adjacent to the terminal.”
RU	3.15			In the Russian Federation, the term “protective conductor” is defined differently: **protective conductor** (identification PE) conductor provided for the purposes of electrical safety, for example protection against electric shock
RU	3.16			In the Russian Federation, the term “protective earthing” is defined differently: **protective earthing** earthing for the purposes of electrical safety

Country	Clause/subclause No.	Nature (permanent or less permanent according to IEC Directives)	Rationale (detailed justification for the requested country note)	Wording
RU	3.18			In the Russian Federation, the term “protective-equipotential-bonding” is defined differently: **protective-equipotential-bonding** equipotential bonding for the purposes of electrical safety
RU	6.2.1			In the Russian Federation, it is not permitted to use separately the GREEN colour and YELLOW colour for identification of conductors.
US	6.2.1			In the United States, the use of the single colour GREEN is permitted for identification of protective earth conductors.
CA	6.2.2			In Canada, the colour identification WHITE or NATURAL GREY for the mid-point or neutral conductor is used as a replacement for the colour identification BLUE.
JP	6.2.2			In Japan, the colour identification WHITE or NATURAL GREY for the mid-point or neutral conductor is used as a replacement for the colour identification BLUE.
RU	6.2.2			In the Russian Federation, the BLUE colour should be used only for identification of the neutral conductors, the mid-point conductors and the earthed line conductors.
US	6.2.2			In the United States, the colour identification WHITE or NATURAL GREY for the mid-point or neutral conductor is used as a replacement for the colour identification BLUE.
US	6.2.2			In the United States, the use of the colour BLUE is permitted for phase conductors. Neutral conductors are permitted to be WHITE, GREY or with three WHITE stripes on insulation other than GREEN.
AU	6.2.3			In Australia, the colour BLACK shall not be used for identification of line conductors of installation wiring. The colour BROWN is acceptable for a single-phase line conductor and BROWN, BROWN and BROWN is acceptable for line conductors L1, L2 and L3.
CA	6.2.3			In Canada, where the colour GREY is used as a replacement for the colour identification BLUE for neutral or mid-point conductor, the colour GREY shall not be used for identification of line conductors in AC systems if confusion is likely.
CA	6.2.3			In Canada, the colour GREY can be applied as identification of the neutral or mid-point conductor; the colour GREY shall not be used for any other purpose than that specified in the Note of this subclause.

Country	Clause/subclause No.	Nature (permanent or less permanent according to IEC Directives)	Rationale (detailed justification for the requested country note)	Wording
JP	6.2.3			In Japan, where the colour GREY is used as a replacement for the colour identification BLUE for the neutral or mid-point conductor, the colour GREY shall not be used for identification of line conductors in AC-systems if confusion is likely.
JP	6.2.3			In Japan, the colour GREY can be applied as identification of the neutral or mid-point conductor; the colour GREY shall not be used for any other purpose than specified in the Note of this subclause.
RU	6.2.3			In the Russian Federation, the preferred colour of the phase conductor of a single-phase electrical circuit is BROWN. When the single-phase electrical circuit is branched from a three-phase electrical circuit, the colour identification of the phase conductor of the single-phase electrical circuit should coincide with the colour identification of that phase conductor of the three-phase electrical circuit to which it is connected electrically.
RU	6.2.3			In the Russian Federation, the preferred colour of the earthed phase conductor is BLUE. If confusion with the neutral conductor, the mid-point conductor or the earthed pole conductor is likely, the alphanumeric designation shall be indicated at the terminations of the earthed phase conductors and in points of their connections.
US	6.2.3			In the United States, where the colour GREY is used as a replacement for the colour identification BLUE for the neutral or mid-point conductor, the colour GREY shall not be used for identification of line conductors in AC systems if confusion is likely.
US	6.2.3			In the United States, the colour GREY can be applied as identification of neutral or mid-point conductor, the colour GREY shall not be used for any other purpose than specified in the Note of this subclause.
RU	6.2.4			In the Russian Federation, the preferred colour of the positive pole conductor is BROWN, the preferred colour of the negative pole conductor is GREY. When the two-wire DC electrical circuit is branched from a three-wire DC electrical circuit, the colour identification of the pole conductor of the two-wire electrical circuit should coincide with the colour identification of that pole conductor of the three-wire electrical circuit to which it is connected electrically.

Country	Clause/subclause No.	Nature (permanent or less permanent according to IEC Directives)	Rationale (detailed justification for the requested country note)	Wording
RU	6.2.4			In the Russian Federation, the preferred colour of the earthed pole conductor is BLUE. If confusion with the neutral conductor, the mid-point conductor or the earthed phase conductor is likely, the alphanumeric designation shall be indicated at the terminations of the earthed pole conductors and in points of their connections.
CA	6.3.2			In Canada, the colour identification GREEN for the protective conductor is used as a replacement for the colour combination GREEN-AND-YELLOW.
JP	6.3.2			In Japan, the colour identification GREEN for the protective conductor is used as a replacement for the colour combination GREEN-AND-YELLOW.
US	6.3.2			In the United States, the colour identification GREEN for the protective conductor is used as a replacement for the colour combination GREEN-AND-YELLOW.
US	6.3.2			In the United States, the use of the single colour GREEN is permitted for identification of protective earth conductors.
US	7.3.2		In the United States, identification of the terminal for the grounded conductor is by coloration.	In the US identification of the terminal for connection of the grounded conductor is by a white colour, or by the word “white” or the letter “W” adjacent to the terminal.
US	7.3.3		In the United States, identification of the equipment grounding conductor is only by coloration of green or green with yellow stripes.	In the US, identification of the equipment grounding conductor is made by GREEN or GREEN with one or more YELLOW stripes for the insulation , other means of coloration, coloured tape or adhesive labels, or stripping the insulation or covering from the entire exposed length of the conductor.
RU	7.3.13			In the Russian Federation, the alphanumeric identification of the phase conductor of a single-phase electrical circuit shall be "L". The alphanumeric identification of the phase conductors of a three-phase electrical circuit shall be "L1", "L2" and "L3". When the single-phase electrical circuit is branched from a three-phase electrical circuit, the alphanumeric identification of the phase conductor of the single-phase electrical circuit should coincide with the alphanumeric identification of that phase conductor of the three-phase electrical circuit to which it is connected electrically.

Country	Clause/subclause No.	Nature (permanent or less permanent according to IEC Directives)	Rationale (detailed justification for the requested country note)	Wording
RU	7.3.13			In the Russian Federation, the alphanumeric identification of the positive pole conductor shall be "L+", and of the negative pole conductor shall be "L–". When the two-wire DC electrical circuit is branched from a three-wire DC electrical circuit, the alphanumeric identification of the pole conductor of the two-wire electrical circuit should coincide with the alphanumeric identification of that pole conductor of the three-wire electrical circuit to which it is connected electrically.
RU	7.3.13			In the Russian Federation, the alphanumeric identification of the earthed phase conductor of a single-phase electrical circuit shall be "LE", and of a three-phase electrical circuit shall be "LE1", "LE2" or "LE3". The alphanumeric identification of the earthed positive pole conductor shall be "LE+", the earthed negative pole conductor shall be "LE–".
AU	Table A.1			In Australia, the colour PINK is the preferred colour for identification of a functional earthing conductor ('FE'), but the colour WHITE is also accepted.
US	Table A.1		Identification of the terminal for equipment grounding conductors, grounding electrode conductors and bonding conductors is not as indicated.	In the US, identification of the terminal for connection of the equipment grounding conductor, grounding electrode conductor or bonding conductors shall be by one of the following: a. Green, not readily removable terminal screw with hexagonal head. b. Green, not readily removable and hexagonal terminal nut. c. Green pressure wire connector. d. If the terminal is not readily visible, marking of the word "green" or "ground", the letters "G" or "GR", a grounding symbol or identification by green colour. [see NFPA 70 National Electrical Code for additional information]

Bibliography

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IEC 60050-195:1998/AMD1:2001

IEC 60050-826:2004, *International Electrotechnical Vocabulary (IEV) – Part 826: Electrical installations*

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IEC 60227-2:1997, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750V – Part 2: Test methods*

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NFPA 70, *National Electrical Code*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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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

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Le présent document a été établi par le comité d'études 3 de l'IEC: Structures d'informations, documentation et symboles graphiques.

Elle a le statut d'une publication fondamentale de sécurité, conformément au Guide 104 de l'IEC.

Cette sixième édition annule et remplace la cinquième édition de l'IEC 60445, parue en 2010.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) le texte de l'introduction a été déplacé dans le domaine d'application conformément au Guide 104 de l'IEC;

b) codes couleur permettant l'identification des conducteurs de ligne dans les systèmes à courant continu;

c) code couleur permettant l'identification d'un conducteur de mise à la terre fonctionnelle;

d) mise à jour du Tableau A.1 intégrant les codes couleur des conducteurs de ligne à courant continu;

e) conversion des notes comportant des exigences non obligatoires en texte normatif;

f) la terminologie est alignée sur l'IEC 60050-195.

Le texte de la présente Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
3/1313/FDIS	3/1326/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette Norme internationale.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

L'attention du lecteur est attirée sur le fait que l'Annexe B énumère tous les articles traitant des différences à caractère moins permanent inhérentes à certains pays, concernant le sujet de la présente norme.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives au document recherché. A cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

Le contenu du corrigendum de novembre 2017 a été pris en considération dans cet exemplaire.

IMPORTANT – Le logo *"colour inside"* qui se trouve sur la page de couverture de cette publication indique qu'elle contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer cette publication en utilisant une imprimante couleur.

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

1 Domaine d'application

Le présent document s'applique à l'identification et au marquage des bornes de matériels électriques, tels que résistances, coupe-circuits à fusibles, relais, contacteurs, transformateurs, machines tournantes et, chaque fois que cela est possible, à des combinaisons de tels matériels (par exemple des ensembles) et s'applique aussi à l'identification des extrémités de certains conducteurs désignés. Il prévoit également des règles générales concernant l'utilisation de certaines couleurs ou de certains caractères alphanumériques pour identifier les conducteurs dans le but d'éviter toute ambiguïté et de garantir la sécurité de fonctionnement. Ces couleurs ou ces caractères alphanumériques destinés aux conducteurs doivent être appliqués aux câbles ou aux noyaux, aux barres omnibus, aux matériels et aux installations électriques.

La présente publication fondamentale de sécurité est principalement destinée à être utilisée par les comités d'études lors de l'élaboration des normes conformément aux principes énoncés dans le Guide IEC 104 et le Guide ISO/IEC 51.

Elle n'est pas destinée à être utilisée par les constructeurs ou les organismes de certification. L'une des responsabilités d'un comité d'études est, le cas échéant, d'avoir recours aux publications fondamentales relatives à la sécurité lors de l'élaboration de ses publications. Les exigences de la présente publication fondamentale de sécurité ne s'appliqueront pas, sauf mention spécifique dans les publications en question.

2 Références normatives

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60417, *Symboles graphiques utilisables sur le matériel*

IEC 60617, *Symboles graphiques pour schémas*

Guide IEC 104, *Elaboration des publications de sécurité et utilisation des publications fondamentales de sécurité et publications groupées de sécurité*

Guide ISO/IEC 51, *Aspects liés à la sécurité – Principes directeurs pour les inclure dans les normes*

3 Termes et définitions

Pour les besoins du présent document, les termes et les définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologies destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/

- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

NOTE Les termes sont triés par ordre alphabétique en anglais.

3.1
matériel électrique
matériel utilisé pour la production, la transformation, le transport, la distribution ou l'utilisation de l'énergie électrique, tel que machine, transformateur, appareillage, appareil de mesure, dispositif de protection, canalisation électrique, matériels d'utilisation

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

3.2
conducteur de liaison fonctionnelle
conducteur prévu pour réaliser une liaison équipotentielle fonctionnelle

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

3.3
mise à la terre pour des raisons fonctionnelles
mise à la terre d'un ou de plusieurs points d'un réseau, d'une installation ou d'un matériel pour des raisons autres que la sécurité électrique

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

3.4
conducteur de mise à la terre fonctionnelle
conducteur de mise à la terre utilisé pour la mise à la terre fonctionnelle

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

3.5
liaison équipotentielle fonctionnelle
liaison équipotentielle réalisée à des fins fonctionnelles autres que la sécurité

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

3.6
conducteur de ligne
DECONSEILLE: conducteur de phase (dans les systèmes à courant alternatif)
DECONSEILLE: conducteur de pôle (dans les systèmes à courant continu)
conducteur sous tension en service normal et capable de participer au transport ou à la distribution de l'énergie électrique, mais qui n'est ni un conducteur de neutre ni un conducteur de point milieu

[SOURCE: IEC 60050-195:1998, 195-02-08]

3.7
conducteur de point milieu
conducteur électriquement raccordé au point milieu et capable de participer à la distribution de l'énergie électrique

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

3.8
conducteur (de) neutre
conducteur relié électriquement au point neutre et pouvant contribuer à la distribution de l'énergie électrique

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

3.9
conducteur PEL
conducteur assurant à la fois les fonctions de conducteur de mise à la terre de protection et de conducteur de ligne

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

3.10
conducteur PEM
conducteur assurant les fonctions de conducteur de mise à la terre de protection et de conducteur de point milieu

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

3.11
conducteur PEN
conducteur assurant à la fois les fonctions de conducteur de mise à la terre de protection et de conducteur de neutre

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

3.12
conducteur de liaison de protection
DECONSEILLE: conducteur d'équipotentialité
conducteur de protection prévu pour réaliser une liaison équipotentielle de protection

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

3.13
conducteur de liaison de protection mis à la terre
conducteur de liaison de protection muni d'un chemin conducteur vers la terre locale

3.14
conducteur de liaison de protection non mis à la terre
conducteur de liaison de protection dépourvu de chemin conducteur vers la terre locale

3.15
conducteur de protection
(identification: PE)
conducteur de mise à la terre du matériel, US
conducteur d'électrode de mise à la terre, US
conducteur prévu à des fins de sécurité, par exemple protection contre les chocs électriques

Note 1 à l'article: Les termes conducteur de mise à la terre du matériel et conducteur d'électrode de mise à la terre sont utilisés aux Etats-Unis en fonction de leur application.

[SOURCE: IEC 60050-195:1998, 195-02-09, modifiée – deux synonymes et une note à l'article ont été ajoutés]

3.16
mise à la terre pour des raisons de protection
mise à la terre d'un ou de plusieurs points d'un réseau, d'une installation ou d'un matériel pour des raisons de sécurité électrique

[SOURCE: IEC 60050-195/AMD1:2001, 195-01-11]

3.17
conducteur de mise à la terre de protection
conducteur de protection prévu pour réaliser la mise à la terre de protection

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

3.18
liaison équipotentielle de protection
liaison équipotentielle réalisée à des fins de sécurité

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

3.19
mettre à la terre, verbe
réaliser une liaison électrique entre un point donné d'un réseau, d'une installation ou d'un matériel et une terre locale

Note 1 à l'article: La liaison à la terre locale peut être
– intentionnelle, ou
– non intentionnelle ou accidentelle
et peut être permanente ou temporaire.

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

3.20
liaison équipotentielle
mise en œuvre de liaisons électriques entre parties conductrices pour réaliser l'équipotentialité

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

3.21
équipotentialité
état des parties conductrices ayant un potentiel électrique sensiblement égal

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

4 Méthodes d'identification

Dans le cas où l'identification des bornes de matériels et des extrémités de certains conducteurs désignés est considérée comme nécessaire, elle doit être réalisée au moyen d'une ou de plusieurs des méthodes suivantes:

– la position physique ou relative des bornes de matériels ou des extrémités de certains conducteurs désignés;
– un code de couleurs pour les bornes de matériels et les extrémités de certains conducteurs désignés conformément à l'Article 6;
– des symboles graphiques conformes à l'IEC 60417. Si des symboles complémentaires sont nécessaires, ils doivent être cohérents avec l'IEC 60617;
– une notation alphanumérique conformément au système détaillé à l'Article 7.

Pour rester en cohérence avec la documentation et la désignation des bornes de matériels, la notation alphanumérique est recommandée.

L'identification des conducteurs par des couleurs doit être conforme aux exigences prévues dans l'Article 6. L'identification des conducteurs par des caractères alphanumériques doit être conforme aux exigences prévues dans l'Article 7.

NOTE Il est reconnu que pour des systèmes et des installations complexes, un marquage et un étiquetage supplémentaires sont utilisés pour des raisons autres que la sécurité, voir par exemple l'IEC 62491.

5 Application des moyens d'identification

La couleur, le symbole graphique ou la notation alphanumérique d'identification doivent se trouver sur la borne correspondante ou à proximité.

Lorsque plusieurs méthodes d'identification sont utilisées, la corrélation entre ces méthodes doit, chaque fois qu'il y a risque de confusion, être clarifiée dans la documentation associée.

Lorsqu'aucune confusion n'est possible, la juxtaposition d'une notation numérique et d'une notation alphanumérique peut être appliquée.

Les bornes et les conducteurs utilisés pour la mise à la terre sont divisés selon leur objectif de mise à la terre en deux concepts de base: la mise à la terre de protection et la mise à la terre fonctionnelle.

– Si une borne ou un conducteur est conforme aux exigences relatives à la mise à la terre de protection et à la mise à la terre fonctionnelle, elle/il doit être désigné(e) comme une borne ou un conducteur de mise à la terre de protection.
– Si les exigences relatives à la mise à la terre de protection ne sont pas respectées par une borne ou un conducteur de mise à la terre fonctionnelle, elle/il ne doit pas être marqué(e) comme étant une borne ou un conducteur de mise à la terre de protection.
– Les exigences relatives à la mise à la terre fonctionnelle doivent être définies par le constructeur ou le comité de produit en question et il convient qu'elles soient spécifiées dans la documentation de l'appareil.

NOTE Par exemple, les exigences relatives à la gestion des problèmes de compatibilité électromagnétique.

6 Identification par des couleurs

6.1 Généralités

Pour l'identification des conducteurs, les couleurs suivantes sont autorisées:

NOIR, MARRON, ROUGE, ORANGE, JAUNE, VERT, BLEU, VIOLET, GRIS, BLANC, ROSE, TURQUOISE.

NOTE Cette liste de couleurs provient de l'IEC 60757.

L'identification par couleur doit être utilisée au niveau des extrémités et de préférence sur toute la longueur du conducteur, soit par la couleur de l'isolation, soit par des marqueurs de couleur, excepté pour les conducteurs nus, pour lesquels l'identification par couleur doit s'effectuer au niveau des points d'extrémité et de raccordement.

L'identification par couleur ou par marquage n'est pas nécessaire pour

– les conducteurs concentriques de câbles,
– la gaine ou l'armure métallique des câbles en cas d'utilisation comme un conducteur de protection,
– les conducteurs nus lorsqu'une identification permanente est impossible,
– les éléments conducteurs étrangers utilisés comme un conducteur de protection,
– les parties conductrices accessibles utilisées comme un conducteur de protection.

Des marquages additionnels, par exemple un marquage alphanumérique, sont autorisés, à condition que l'identification par couleur reste sans ambiguïté.

6.2 Utilisation de couleurs uniques

6.2.1 Couleurs autorisées

Le VERT et le JAUNE sont les seules couleurs autorisées lorsqu'aucune confusion avec le code couleur des conducteurs conformément à 6.3.2 jusqu'à 6.3.6 n'est possible.

6.2.2 Conducteur de neutre ou de point milieu

Lorsqu'un circuit comprend un conducteur de neutre ou de point milieu identifié par une couleur, la couleur utilisée à cet effet doit être le BLEU. Afin d'éviter toute confusion avec d'autres couleurs, il est recommandé d'utiliser un BLEU non saturé, souvent appelé "bleu clair". Le BLEU ne doit pas être utilisé pour identifier un autre conducteur lorsqu'une confusion est possible.

En l'absence de conducteur de neutre ou de point milieu, un conducteur identifié par du BLEU dans l'ensemble des canalisations électriques peut être utilisé à toute autre fin, excepté comme un conducteur de protection.

En cas d'utilisation d'une identification par couleur, les conducteurs nus utilisés comme des conducteurs de neutre ou de point milieu doivent être, soit marqués par une bande BLEUE de 15 mm à 100 mm de large dans chaque unité ou enveloppe et chaque partie accessible, soit colorés en BLEU sur toute leur longueur.

NOTE Dans l'IEC 60079-11, la couleur BLEUE est utilisée pour le marquage par la couleur des bornes, des boîtes à bornes, des fiches et des socles de circuits de sécurité intrinsèque.

6.2.3 Conducteur de ligne dans un système à courant alternatif

Pour les conducteurs de ligne dans les systèmes à courant alternatif, les couleurs préférentielles sont le NOIR, le MARRON et le GRIS.

NOTE L'ordre des codes de couleur donnés en 6.2.3 est alphabétique et n'indique aucune préférence dans l'ordre des phases ou le sens de rotation.

6.2.4 Conducteur de ligne dans un système à courant continu

Pour les conducteurs de ligne dans les systèmes à courant continu, les couleurs préférentielles sont:

– le ROUGE pour le conducteur de ligne positif,
– le BLANC pour le conducteur de ligne négatif.

6.2.5 Conducteur de mise à la terre fonctionnelle

Pour le marquage par couleur d'un conducteur de mise à la terre fonctionnelle, la couleur préférentielle est le ROSE. L'application de la couleur est nécessaire uniquement au niveau des extrémités et des points de connexion.

6.3 Utilisation de combinaisons bicolores

6.3.1 Couleurs autorisées

Les combinaisons de deux des couleurs répertoriées en 6.1 sont autorisées à condition que tout risque de confusion soit impossible.

Afin d'éviter toute confusion, la couleur VERTE et la couleur JAUNE ne doivent pas être utilisées dans des combinaisons de couleurs autres que la combinaison VERT/JAUNE.

L'utilisation de la combinaison des couleurs VERT/JAUNE est restreinte aux cas énoncés de 6.3.2 à 6.3.6.