INTERNATIONAL ELECTROTECHNICAL COMMISSION

Technical Committee No. 3: Information structures, documentation and graphical symbols

Occurrence-related marking of conductors

1 Introduction

The following proposal is the result of now and then upcoming questions of marking of conductors.

The document is intended for a short discussion at the TC3 workshop in the context of the revision of IEC 61346. Depending on the reactions the proposal could be the subject of a NWIP.

2 IEC 391 Marking of insulated conductors

The publication IEC 391 *Marking of insulated conductors*, was issued 1972, under the responsibility of IEC TC16.

The English version of the content of the publication is attached as Annex B.

The publication deals with the marking of conductors/cables in their role as constituents of an equipment or installation, and is thus closely related to the application of the reference designation system in accordance with IEC 61346.

The methods dealt with are:

a) Dependant marking
   - Dependant local-end marking
   - Dependant remote-end marking
   - Dependant both-end marking

b) Independent marking

c) Composite marking

This is a quite different marking issue compared to those covered in e.g. IEC 60446 *Identification of conductors by colours or numerals* or IEC 60227 *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 1: General requirements*

One use case for the standard is control equipment and cubicles in which there are many single core conductors that need to be identified in both ends, another one is the identification of cables in large installations.

Minor building installations are not typical use cases, as the identification of conductors by colours and the identification of cable cores by colours or numerals is normally sufficient in this case.

The standard specified and a number of methods for marking by appropriate descriptions and illustrations, but did not specify which of them to use and under which circumstances. From this
perspective it was not a very “strong” standard, but it limited anyway the number of applicable methods and provided a means for clear identification of them.

The publication was withdrawn 1995 as a result of a systematic review. The result of this is documented in 16/353/RVS: There were three votes for maintaining it, 1 for revising it and 5 for withdrawal.

This result of the voting and the comments are summarized in Annex A.

3 The need

At larger industrial installations it is often considered necessary to apply a clear marking, especially for cables and cable cores, but also for conductors in control cubicles and switchgear. A basic rule is that if you cannot visually follow a conductor from one end to the other it has to be marked.

Two main methods are used practically:

- addition of a marking at the conductor or cable ends; or
- use of multi-coloured coded conductors (conductors with stripes).

IEC 60204-1 and IEC 60694 are examples of standards containing requirements for these kinds of marking:

**IEC 60204-1 Safety of machinery – Electrical equipment of machines – Part 1: General requirements**

14.2 Identification of conductors

14.2.1 General requirements

Conductors shall be identifiable at each termination in accordance with the technical documentation (see clause 18). Annex B question 31 may be used for agreement between supplier and user regarding a preferred method of identification. Where colour-coding is used for identification of conductors, the following colours may be used: BLACK, BROWN, RED, ORANGE, YELLOW, GREEN, BLUE (including LIGHT BLUE), VIOLET, GREY, WHITE, PINK, TURQUOISE.

NOTE - This list of colours is derived from IEC 60757.

It is recommended that, where colour is used for identification, the colour be used throughout the length of the conductor either by the colour of the insulation or by colour markers. An acceptable alternative may consist of additional identification at selected locations.

For safety reasons, the colour GREEN or the colour YELLOW should not be used where there is a possibility of confusion with the bicolour combination GREEN-AND-YELLOW (see 14.2.2). Colour identification using combinations of those colours listed above may be used provided there can be no confusion and that GREEN or YELLOW is not used except in the bicolour combination GREEN-AND-YELLOW.

----------

14.2.4 Identification of other conductors

Identification of other conductors shall be by colour (either solid or with one or more stripes), number, alphanumeric, or a combination of colour and numbers or alphanumeric. When numbers are used, they shall be Arabic; letters shall be Roman (either upper or lower case). It is recommended that insulated conductors be colour-coded as follows:

- BLACK: a.c. and d.c. power circuits;
- RED: a.c. control circuits;
- BLUE: d.c. control circuits;
- ORANGE: interlock control circuits supplied from an external power source.

----------
Annex B Question 31:

31. Do you need a specific method of conductor identification to be used for the conductors referred to in 14.2.1? YES __ NO__ Type___?

IEC 60694 Common specifications for high-voltage switchgear and controlgear standards
5.4.4.5 Requirements for auxiliary and control circuit components
5.4.4.5.1 Cables and wiring

The method and extent of identification of conductors, for example by numbers, colours or symbols, is the responsibility of the manufacturer. Identification of conductors shall be in agreement with the wiring diagrams and drawings, and the specification of the user, if applicable. This identification may be limited to the ends of the conductors. Where appropriate, identification of wiring according to IEC 60445 may be applied.

From the examples can be seen that

- identification of the conductors is required;
- both the main methods are referred to in standards;
- both examples emphasize the relation to the documentation.

However, details of the marking are not specified anywhere and the means to specify “Type” in the questionnaire in IEC 60204 is missing.

It is recognized that when the number of conductors/cables meeting in the same place in an equipment or installation is low the use of only a few colours for single core conductors or the colour coding or numbering of the cores in a cable might be sufficient, but this is not always the situation.

Furthermore, from some comments contained in 16/353/RVS, it can be suspected that some negative votes did not really consider the need of this standard by equipment and plant manufacturers but only the needs by cable manufacturers.

4 Proposal

The subject of marking of conductors should be covered by an IEC standard.

A new standard should be clear with regard to the principles documented in the earlier IEC 391, but also that the marking of a conductor could refer:

1. to the documentation;
2. to the terminals that it connects; or
3. to the function or signal it is intended for.

In the cases 1 and 2 the reference designations shall be used; for the conductor in case 1 and for the terminals in case 2. The cases 2 and 3 illustrate a kind of “on site documentation” and should possibly be restricted to become a supplementary marking.

Since the subject is closely related to the application of IEC 61346, it is suggested that it is considered as part of the revision of IEC 61346, either to be integrated in an existing part or as a new part on how reference designations are applied to objects, including conductors.
An extension of IEC 61666, (presently dealing with *Identification of terminals within a system*), to include both terminals and conductors could also be considered in connection with the forthcoming maintenance of this publication.

An intermediate solution might be to "revive" the old IEC 391 or parts of it, and after minimum editing for adaptation to the present IEC 61346, publish it as an IEC/PAS 60391.

Any concrete action should of course be carried out with appropriate involvement of IEC TC16.

5 Possible extension

A similar need for marking exists for pipes in pneumatic equipment. (Such pipes might be flexible and in many ways possible to handle physically like electrical conductors.) Presently, no ISO standard for marking exists in this area. It might be an advantage if similar principles for the marking could be applied, and coordination with ISO might therefore be useful.
Annex A
Summary of 16/353/RVS

Comments to 16/353/RVS

<table>
<thead>
<tr>
<th>Country</th>
<th>Comments to IEC Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>This IEC Recommendation is not used in practice.</td>
</tr>
<tr>
<td>Spain</td>
<td>The standard is obsolete.</td>
</tr>
<tr>
<td>Finland</td>
<td>The Publication IEC 391 should be revised in co-operation with TC3 taking into account the present development of documentation.</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Standard not currently used. CENELEC and national standards used. (...) cable manufacturers use HD 364.</td>
</tr>
<tr>
<td>Norway</td>
<td>Obsolete. Not in use anymore.</td>
</tr>
<tr>
<td>U.S.A</td>
<td>We know of no standards that would use IEC 391.</td>
</tr>
</tbody>
</table>
Annex B
IEC 391: 1975 Marking of insulated conductors

This annex contains a scanned copy of the (odd numbered) English pages of IEC 391.

It consists of 14 pages.
Marques de repérage des conducteurs isolés

Marking of insulated conductors
## CONTENTS

<table>
<thead>
<tr>
<th>Clause</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOREWORD</td>
<td>5</td>
</tr>
<tr>
<td>PREFACE</td>
<td>5</td>
</tr>
<tr>
<td>1. Scope</td>
<td>7</td>
</tr>
<tr>
<td>2. Object</td>
<td>7</td>
</tr>
<tr>
<td>3. Definitions</td>
<td>7</td>
</tr>
<tr>
<td>4. General rules</td>
<td>11</td>
</tr>
<tr>
<td>5. Application of the systems of main markings</td>
<td>11</td>
</tr>
<tr>
<td>6. Supplementary marks</td>
<td>19</td>
</tr>
<tr>
<td>7. Arrangement of marks</td>
<td>21</td>
</tr>
<tr>
<td>8. Relative positions of marks</td>
<td>23</td>
</tr>
<tr>
<td>9. Characters to be used</td>
<td>27</td>
</tr>
<tr>
<td>10. Inscription on diagrams of marks carried by conductors (or groups of conductors)</td>
<td>27</td>
</tr>
</tbody>
</table>
FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote this international unification, the IEC expresses the wish that all National Committees having as yet no national rules, when preparing such rules, should use the IEC recommendations as the fundamental basis for these rules in so far as national conditions will permit.

4) The desirability is recognized of extending international agreement on these matters through an endeavour to harmonize national standardization rules with these recommendations in so far as national conditions will permit. The National Committees pledge their influence towards that end.

PREFACE

This Recommendation has been prepared by Technical Committee No. 16, Terminal markings and other identifications.

Drafts were discussed at the meetings held in Naples in 1956 and in Venice in 1963. As a result of this latter meeting, a new draft was submitted to the National Committees for approval under the Six Months' Rule in July 1967 and some amendments under the Two Months' Procedure in December 1968.

The following countries voted explicitly in favour of publication:

- Australia
- Austria
- Belgium
- Czechoslovakia
- Canada
- Denmark
- Finland
- France
- Germany
- Iran
- Israel
- Japan
- Netherlands
- Norway
- Poland
- South Africa
- Sweden
- Switzerland
- Turkey
- Yugoslavia
MARKING OF INSULATED CONDUCTORS

1. Scope

This Recommendation applies to the marking of insulated conductors used in industrial installations and the equipment which forms part of them, except insulated conductors constituting the terminals of electrical apparatus (for example, rotating machines or transformers).

It applies only to other installations and equipment (for example, telecommunication circuits or circuits including telecommunication equipment) when reference is made to them.

2. Object

The object of this recommendation is to define the systems of identification marking to use for insulated conductors.

It distinguishes two types of markings:
— main markings;
— supplementary markings.

The purpose of marking insulated conductors is to provide, if necessary, a means whereby conductors can be identified in the circuit, and also after they have been detached from the terminals to which they were connected.

3. Definitions

For the purpose of this recommendation, the terms used have the following meanings:

3.1 Terminal

A conducting element of a piece of apparatus, designed for connecting it to external circuits.

3.2 Terminal board

A board or block or strip carrying several terminals insulated from each other and usually from earth.

3.3 Identification mark

A mark which identifies a conductor or a group of conductors at each end and, when necessary, at visible points throughout its length.

3.4 Systems of marking

3.4.1 Main marking

A system of marking characterizing each conductor or group of conductors irrespective of their electrical function.
a) **Dependent marking**

A system of marking conductors, or groups of conductors, based on the markings of the terminals at which the conductors terminate or of the equipment to which the groups of conductors are connected.

1) **Dependent local-end marking**

   Of a conductor:

   A system of marking in which the marking of a conductor end is the same as that of the terminal to which it is connected.

   Of a group of conductors:

   A system of marking in which the marking of a group of conductor ends indicates the part of equipment to which it is connected.

2) **Dependent remote-end marking**

   Of a conductor:

   A system of marking in which the marking of a conductor end is the same as that of the terminal to which its remote end is connected.

   Of a group of conductors:

   A system of marking in which the marking of a group of conductor ends indicates the part of equipment to which its remote end is connected.

3) **Dependent both-end marking**

   Of a conductor:

   A system of marking in which each end of a conductor is marked both with the marking of the terminal to which it is connected and also with that of the terminal to which its remote end is connected.

   Of a group of conductors:

   A system of marking in which each end of a group of conductors is marked to indicate both the part of equipment to which it is connected and also the part of equipment to which its remote end is connected.

b) **Independent marking**

A system of marking of conductors or groups of conductors, independent of the marking of the terminals at which the conductors terminate or of the equipment to which the groups of conductors are connected.

c) **Composite marking**

A system of marking in which dependent marking and independent marking are used together.
3.4.2 Supplementary marking

A system of marking generally used as a supplement to the main marking and based on the electrical function of each conductor or group of conductors.

a) Functional mark

A supplementary mark indicating:

— either the function of each conductor considered individually (examples: switching on or off, signalling a position, measurement of a current or a voltage);

— or the function of several conductors considered together (examples: heating, lighting, signalling, measuring circuits).

b) Phase mark

A supplementary mark showing to which phase of an a.c. system a conductor is connected.

c) Polarity mark

A supplementary mark showing to which pole of a d.c. circuit a conductor is connected.

4. General rules

4.1 The identification marks shall be placed at the ends of conductors and, where necessary, at visible points along their length.

4.2 The main markings shall be of one of the types defined in Sub-clause 3.4.1.

4.3 Conductors may carry supplementary marks as defined in Sub-clause 3.4.2. In some cases, these supplementary markings may be sufficient and there may be no need for main marking.

5. Application of the systems of main markings

5.1 Dependent marking

In dependent marking (Sub-clause 3.4.1.a) conductor marks may include (Figures 2 and 4) or may not include (Figures 1 and 3) equipment marks; however, conductor marks shall always include equipment marks when the use of terminal marks alone would be confusing (Figure 2).

5.1.1 Dependent both-end marking (Sub-clause 3.4.1.a.3)

This system illustrated in Figures 1 and 2 permits the conductor to be connected to its local-end terminal without having to refer to a diagram or a connection table and indicates also its remote-end terminal, thus facilitating fault location and maintenance work.
Fig. 1. — Example of dependent both-end marking for two conductors.

Fig. 2. — Example of dependent both-end marking for two conductors and for a group of conductors (cable).

*Note.* — For the order of inscription of the marks, see Clause 8.

5.1.2 *Dependent local-end marking* (Sub-clause 3.4.1. a.1)

This system, illustrated in Figure 3, is simpler than the system in Clause 5.1.1, but a diagram or a connection table may be necessary when faults have to be located or maintenance work done, if the actual run of the conductor is not immediately apparent.

Fig. 3. — Example of dependent local-end marking for two conductors.
5.1.3 Dependent remote-end marking (Sub-clause 3.4.1.a.2)

This system, of which Figure 4 gives an example, is also simpler than both-end marking and is convenient for fault location and maintenance work, but it usually necessitates a diagram or a connection table, to enable any connection which may have been removed to be replaced correctly.

Fig. 4. — Example of dependent remote-end marking for three conductors and for a group of conductors (cable).

5.2 Independent marking

In independent marking (Sub-clause 3.4.1.b), the same marking, usually of a simple form, is used all along the conductor, even if it has junctions in its run. Except in certain simple cases, a connection-diagram or table should be used to make it clear to which terminal each conductor end should be connected.

Fig. 5. — Example of independent marking for two conductors and for a group of conductors (cable).

The connection table, if made use of, should indicate:

Conductor 5 connects A1 to D1;
Conductor 6 connects A3 to D2.

Note. — The decision to make use of a diagram or connection table is to be left to the user.
When a functional mark is a complete means of identification, it may be used as an independent marking without adding other markings (Clause 4.3, figure 6).

![Diagram](image-1.png)

**Fig. 6. — Example of functional marking.**

### 5.3 Composite marking

Composite marking (Sub-clause 3.4.1.c) offers the advantages of dependent marking and permits a simplification of any intermediate marking that may be required along the conductor.

If dependent marking is not complete, and does not make use of both ends, a diagram or connection table may be necessary.

![Diagram](image-2.png)

**Fig. 7. — Example of composite marking for two conductors.**

![Diagram](image-3.png)

**Fig. 8. — Example of composite marking: independent for the conductors; dependent both-end for the conductor group (cable).**
The connection table, if made use of, should indicate:

Conductor 5 connects A1 to D1;
Conductor 6 connects A3 to D2.

Fig. 9. — Example of composite marking: dependent both-end marking for the conductors; independent for the conductor group (cable).

The connection table, if made use of, should indicate:

Conductor group (cable) 15 connects terminal boards A and D.

6. Supplementary marks

Supplementary marks (Clause 3.4.2) may be letters or figures, like the main marks. Colour marks or appropriate symbols may also be used. In some cases, to avoid confusion, it is preferable to separate the supplementary marks from the main marks by punctuation signs (e.g. an oblique stroke: /).

6.1 Functional marks

If functional marks (Clause 3.4.2. a) are used, they should be in agreement either with National Rules in force, or with a table which gives their meaning.

6.2 Phase marks

Where phase marks (Clause 3.4.2. b) are used, the hour (clock face) number system should be applied, if possible, as described in IEC Publication 152: Recommendation for the identification by hour numbers of the phase conductors of three-phase electric systems. Where that system is not applicable, capital letters or figures, or both, should be used in phase sequence order.

The neutral conductor of an a.c. system should be indicated by the letter "N".

Note. — If confusion is possible, the hour numbers or other figures or letters, used to indicate the phase, should be placed between oblique strokes (e.g. /8/).
6.3 **Polarity marks**

Where symbols are used to indicate the polarity of a conductor of a direct current circuit (Clause 3.4.2. c), the following marks should be used:

- + for the positive pole,
- — for the negative pole,
- M for the mid-wire for d.c. system.

*Note.* — If there is a risk of confusion between a hyphen and the mark for the negative pole, the latter should be indicated by a hyphen in parentheses "(-)".

6.4 **Protection and/or earthing marks**

Under consideration.

7. **Arrangement of marks**

7.1 If a mark includes various elements, each of these should be distinguished from the others, e.g.:

- by an interval, or an appropriate sign, e.g. a hyphen,
- by the use of different typographic characters,
- by arrangement in columns, see Sub-clause 7.2.

7.2 The different elements constituting a mark should be inscribed either:

- along the axis of the conductor (longitudinal marking),
- across the axis of the conductor (transverse marking).

In all cases, the characters should be so placed as to facilitate reading. They may be arranged in a column or in a row (see Figure 10), and shall then be read from top to bottom and from left to right.

![Figure 10](image)

**FIG. 10.** — Examples of arrangements of marks on conductors or conductor groups (cables).
8. Relative positions of marks

8.1 Dependent marking

8.1.1 In the case of dependent marking (local-end or remote-end), the order in which the marks should be written is as follows:
— the corresponding terminal mark,
— if necessary, the supplementary marks (see Clause 6).

Figure 11 gives examples:

![Diagram](image)

Fig. 11. — Examples of dependent marking with supplementary mark S.

8.1.2 In the case of dependent both-end marking, of which Figure 12 gives three examples, the order is as follows:
— the mark of one of the two terminals,
— if necessary, the supplementary marks (see Clause 6),
— the mark of the other terminal.

![Diagram](image)

Example A: Identical marks on both ends.
Example B: Different marks on each end.
Example C: Intermediate mark only.

Fig. 12. — Examples of the order of marking in the dependent both-end marking.
8.2 Independent marking

In the case of independent marking, the order is as follows:

— the identification mark of the conductor,
— if necessary, the supplementary marks (see Clause 6).

Figure 13 gives an example:

\[ \text{16} = \text{Identification mark of the conductor.} \\
\text{S} = \text{Supplementary mark.} \]

**Fig. 13. — Independent marking.**

8.3 Composite marking

In the case of composite marking of a conductor, the order is as follows:

— the mark of one terminal,
— the independent mark of the conductor,
— if necessary, the supplementary marks (see Clause 6),
— finally, the mark of the other terminal (in the case of dependent both-end marking).

Figure 14 gives four examples:

\[ \text{a) Remote-end marking} \]

\[ \text{b) Local-end marking} \]

\[ \text{c) Both-end marking} \]

(identical marks on both ends)
9. **Characters to be used**

Marks should be written as far as possible in Roman capitals and in Arabic numerals or in standardized graphical symbols.

In the case of dependent marking, however, the marks should be written as far as possible in the same characters as are used for the terminal markings.

10. **Inscription on diagrams of marks carried by conductors (or groups of conductors)**

10.1 To indicate on a diagram the mark carried by a conductor, the mark should be inscribed close to the conductor symbol, as shown in the preceding figures.

10.2 Where dependent both-end marking is used, the sequence of the terminal markings of which the conductor marking is made up shall be the same on the diagram as on the conductor, at both ends.

10.3 Supplementary marks, according to their function, may be written:

- on the diagram only,
- on certain conductors only or on all of them,
- on both the diagram and the conductors.

---

**d/ Both-end marking**

(different marks on each end)

16 = Identification mark of the conductor.

S = Supplementary mark.

**Fig. 14. — Examples of composite marking.**

*Note.* — In some cases it may be appropriate to add additional significance to the order of the symbols. For example, in the dependent both-end marking it may be agreed that the marking of the local end terminal is placed next to the conductor end (see Figure 12, example B).