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Environmental Engineering (EE);
Colour and marking of DC cable and connecting devices

Reference

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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Environmental Engineering (EE).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

The present document has been developed to assist the ICT industry in their development and wider use of DC powering solutions above the DC voltage range mainly used until now for Telecommunication networks equipment (-48 V ETSI EN 300 132-2 [7]).

The present document has been jointly developed by ETSI TC EE and ITU-T Study Group 5 in order to ensure an equivalent technical content. It is published respectively by ITU as Recommendation ITU-T L.1203 [1] and ETSI Standard ETSI ES 203 408.

DC has been the main source of power of Telecommunication industry since the very beginning as it is efficient, reliable and easily scalable.

This solution is a well proven arrangement that has been used for a century in almost all of the sites in cohabitation with AC for servers and other buildings services (lighting, facility plugs, lifts, etc.).

It is recognized that DC has many potential applications further to those for ICT and that such applications could benefit from the standards defined in ITU/ETSI. It is also recognized that further standardization activities on LVDC is now starting in other standardization organizations such as IEC. Thus ITU-T/ETSI will pursue cooperation with such organizations to reach maximum international alignment.

ETSI and ITU-T have standardized the widespread DC power interface at inputs of Telecom/ICT equipment used in Telecom networks, Data centers, and customer sites. The legacy interface for billions of equipment is the SELV voltage range so called -48V, where the plus pole is grounded as defined for example for interface "A" in ETSI EN 300 132-2 [7]. Other complementary ETSI standards define a whole DC distribution including earthing and bonding such as ETSI EN 300 253 [9].

Higher voltages than 48 V are already widely used in Telecom networks for remote powering of signal repeaters on copper or optical Telecom transmission lines, with a usual operation in symmetrical voltage up to +/- 200 V in RFT-C or RFT-V telecom remote power feeding standardized in ETSI EN 302 099 [i.1].

Higher power density of ICT equipment and overall site power in MW for Data centers, have led to the use of higher voltage firstly in AC single or 3 phases up to 400VAC at the input of servers. The need for resilience, energy efficiency and cost optimization has pushed the introduction of the up to 400VDC power feeding interface standardized in ETSI EN 300 132-3-1 [8] and in Recommendation ITU-T L.1200 [2]. This is now available on many servers and network equipment.

As there is a progressive introduction of the new DC power interface in cohabitation with existing -48 V and AC distribution, a new standard ETSI EN 301 605 [10] has been introduced to ensure safety and proper operation especially in mass bonding of EMC sensitive equipment and correct earthing connection to the building structure earthing network.

It appears that there is also a strong need for Telecom/Data centers operators, equipment manufacturers or installers and end customers to clarify the colour and marking of cables in their installations. This would avoid confusion and errors between the different AC and DC power interfaces and distributions used in the building and inside ICT systems.

Considering the user side, and very long background experience in use of DC of the Telecom sector, the present document makes Recommendations directly contributing to safety principles laid down in IEC Guide 104 [i.9] and ISO/IEC Guide 51 [i.10]. It accelerates and encourages the preparation of international standards of cable identification intended for use by manufacturers, users or certification bodies. The present document makes reference to existing IEC standards such as IEC 60445 [3] and IEC 60050-195 [i.2].

For useful information, colours of cables inside equipment are considered in annex A as DC is already widely used, e.g. all the electronic being working only in DC, car and trucks electric circuit being in DC, solar PV power plants, etc.

1 Scope

The scope of the present document is to define common practice for identification of cabling or parts of the DC electric distribution for the Telecom sites (buildings/rooms) feeding ICT and facilities equipment (power plant, cooling, building access systems, monitoring, etc.).

This applies to 400VDC cabling for Telecom, ICT equipment and environment equipment using interface defined in ETSI EN 300 132-3-1 [8] or Recommendation ITU-T L.1200 [2] and avoids confusion between the DC colour and marking of up to 400VDC distribution and the other power interfaces identification: -48VDC distribution for A interface, AC and uninterrupted AC given by inverters or UPS used in the building.

The Recommendation defines:

- requirements for the colour and identification of separate wires used in DC distribution systems and installations, and as much as possible inside equipment between A or P interface and end use;
- marking and identification of DC multiwire cables, connectors and any associated equipment for DC power distribution;
- marking identification for sui-distribution boards and interconnection boxes.

For DC wires in multiwire cables Recommendations are given for harmonization with separate wire requirements.

Recommendations are given on other distribution items (wires, cables and interconnection items) including the functional earthing and bonding arrangement for distribution outside and inside equipment to avoid any confusion with DC distribution identification of the present document.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] Recommendation ITU-T L.1203: "Colour and marking identification of up to 400VDC power distribution for ICT systems".

[2] Recommendation ITU-T L.1200 (2012): "Direct current power feeding interface up to 400 V at the input to telecommunication and ICT equipment".

[3] IEC 60445 Ed 5.0 2010-08: "Basic and safety principles for man-machine interface, marking and identification - Identification of equipment terminals, conductor terminations and conductors".

[4] IEC 60757 (1983): "Code for designation of colours".

[5] IEC 60417DB (2002): "Graphical symbols for use on equipment".

[6] IEC 60617DB (2012): "Graphical symbols for diagrams".

NOTE: IEC DB documents refer to Database of Graphical Symbol. Some are joint with ISO e.g. IEC 60417 and ISO 7000.

[7] ETSI EN 300 132-2 (2016): "Environmental Engineering (EE); Power supply interface at the input to telecommunications and datacom (ICT) equipment; Part 2: Operated by -48 V direct current (dc)".

[8] ETSI EN 300 132-3-1 (2012): "Environmental Engineering (EE); Power supply interface at the input to telecommunications and datacom (ICT) equipment; Part 3: Operated by rectified current source, alternating current source or direct current source up to 400 V; Sub-part 1: Direct current source up to 400 V".

[9] ETSI EN 300 253 (2015): "Environmental Engineering (EE);Earthing and bonding of ICT equipment powered by -48 VDC in telecom and data centres".

[10] ETSI EN 301 605 (2013): "Environmental Engineering (EE); Earthing and bonding of 400 VDC data and telecom (ICT) equipment".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI EN 302 099: "Environmental Engineering (EE); Powering of equipment in access network".

[i.2] IEC 60050-195 (1998): "IEC Terminology International Electrotechnical Vocabulary - Part 195: Earthing and protection against electric shock".

[i.3] IEC 60050-826 (2004): "International Electrotechnical Vocabulary - Part 826: Electrical installations".

[i.4] British Standard BS 7671 (2008): "Requirements for Electrical Installations. IET Wiring Regulations".

[i.5] HD 308 S2:2001: "Identification of cores in cables and flexible cords".

[i.6] HD 324 S1 (1977): "Colored insulation and bare wire identification package".

[i.7] HD 384.5.514: "Identification, including 514.3: Identification of conductors, now withdrawn".

[i.8] IEC 60364-1 (2005): "Low-voltage electrical installations - Part 1: Fundamental principles, assessment of general characteristics, definitions".

[i.9] IEC Guide 104: "The preparation of safety publications and the use of basic safety publications and group safety publications".

[i.10] ISO/IEC Guide 51: "Safety aspects - Guidelines for their inclusion in standards".

[i.11] IS0 6722 (2006): "Road vehicles - 60 V and 600 V single-core cables - Dimensions, test methods and requirements".

[i.12] ISO 2574 (1994): "Flying machine electric cable - Identification marking".

NOTE: Available at http://www.iso.org/iso/fr/home/store/catalogue_ics/catalogue_detail_ics.htm?ics1=1&ics2=70&ics3=&csnumber=7536.

[i.13] ISO 9247 (1990): "Ground work machine - electric wire and cables -- identification and marking principles".

NOTE: Available at http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=16897.

[i.14] IEC EN 60204-1 (2000): "Safety of machinery -Electrical equipment of machines -Part 1:General requirements".

NOTE: IEC/EN 60204-1 is now "Appliance of reference designations on machinery" in accordance with ISO/IEC/EN 81346 (September 2010) EU Directive 2006/42/EC on machinery (www.81346.com).

[i.15] IEC 60304 (1982): "Standard colours for insulation for low-frequency cables and wires".

[i.16] RAL® colour system.

NOTE 1: Refered to as "RAL" in the present document, available at http://www.ralcolours.com/.

NOTE 2: RAL® is the trade name of a colour matching system supplied by by the RAL gGmbH (RAL non-profit LLC), which is a subsidiary of the German RAL Institute. This information is given for the convenience of users of the present document and does not constitute an endorsement by ETSI of the product named. Equivalent products may be used if they can be shown to lead to the same results.

[i.17] United States Federal Standard Colour system.

NOTE: Available at http://www.federalstandardcolour.com/.

[i.18] Pantone® colour system.

NOTE 1: Available at http://www.pantone-colours.com/.

NOTE 2: Pantone® is the trade name of a colour matching system supplied Pantone Inc. This information is given for the convenience of users of the present document and does not constitute an endorsement by ETSI of the product named. Equivalent products may be used if they can be shown to lead to the same results.

[i.19] IEC 60446 (withdrawn) (2007): "Basic and safety principles for man-machine interface, marking and identification - identification of conductors by colours or alphanumerics".

[i.20] CCSA YD/T 2378 (2011): "240V Direct Current Power supply system for Telecommunications".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

48VDC: -48 Volt Direct Current voltage as defined in ETSI EN 300 132-2 [7]

400VDC: up to 400 Volt Direct Current voltage as defined in Recommendation ITU-T L.1200 [2]

electrical equipment: item used for purposes like generation, conversion, distribution or utilization of electric energy (e.g. electrical machines, transformers, switch gear and control gear, measuring instruments, wiring systems, current-using equipment, etc.) (IEC 60050-826 [i.3])

identification: colour, graphical symbol, text in alphanumeric notation located on or adjacent to wire or cable terminals or junction boxes

IT (Isolation Terra): Isolation Terra earthing as defined in IEC 60364-1 [i.8]

NOTE: The two letters IT are coding one of the 3 families of electrical distribution where connection to earth is made through high resistance or impedance device i.e. HRMG in ETSI EN 301 605 [10].

line conductor: AC phase conductor or DC pole conductor (deprecated) conductor which is energized in normal operation and capable of contributing to the transmission or distribution of electric energy but which is not a neutral conductor (IEC 60050-195 [i.2])

RAL: colour coding for industry use [i.16]

TNS: AC distribution earthing arrangements as defined in IEC 60364-1 [i.8] where earthing and neutral wires are separated

3.2 Symbols

For the purposes of the present document, the following symbols apply:

A (interface)	ICT/Telecom equipment -48VDC power interface in ETSI EN 300 132-2 [7]
A3 (interface)	ICT/Telecom equipment up to 400VDC power interface in ETSI EN 300 132-3-1 [8]
P	ICT equipment up to 400VDC power feeding interface in Recommendation ITU-T L.1200 [2]

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3-D	3 Dimension
AC	Alternative Current
CMYK	Cyan, Magenta, Yellow, Key black
DC	Direct Current
EMC	Electro Magnetic Compatibility
HRMG	High Resistance Middle point Grounding
HTML	HyperText Mark-up Language
ICT	Information and Communication Technologies
IT	Information Technology
LVDC	Low Voltage Direct Current
MW	MegaWatt (unit)
OFC	Oxygen Free Cable
PE	Protected Earthing conductor
PEL	Protective Earthing conductor and Line conductor IEC 60050-195 [i.2]
PEN	Protective Earthing conductor and Neutral conductor IEC 60050-195 [i.2]
PV	Photovoltaic
RA	Remote Access
RFT-C	Remote Feeding Telecom-Current
RFT-V	Remote Feeding Telecom-Voltage
RGB	Red Green Blue
RYB	Red Yellow Blue
SELV	Safe Extra Low Voltage
UPS	Uninterrupted Power Supply
VAC	Voltage Alternating Current
VDC	Voltage Direct Current

4 Electrical Distribution identification coverage

The DC Electrical Distribution needs marking at the following different points:

- DC distribution lines (wires and cables)
- DC cabling inside DC power sources
- DC outputs from DC power systems with protective devices
- DC sub-distribution boards (with protective devices)
- DC interconnection boxes
- DC power plugs strips inside ICT equipment rooms and cabinets