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**Environmental Engineering (EE);
Earthing and bonding of 400 VDC data and telecom (ICT) equipment**

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Contents

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Foreword

This final draft European Standard (EN) has been produced by ETSI Technical Committee Environmental Engineering (EE), and is now submitted for the Vote phase of the ETSI standards EN Approval Procedure.

The present document has been produced within the framework of the following considerations:

a) Datacommunications and Telecommunications (ICT) equipment is generally installed in data and telecom centres and held in racks, cabinets or other mechanical structures;

b) the existing ITU-T and ITU-R Recommendations and CENELEC standards in such matters do not ensure the required standardization at the equipment level;

c) network operators and equipment providers agreed to standardize on a bonding configuration that facilitates:

- compliance with functional requirements including Electromagnetic Compatibility (EMC) aspects of emission and immunity;
- compatible building and equipment provisions;
- installation of new data and telecom centres as well as expansion or replacement of installations in existing data and telecom centres with equipment coming from different suppliers;
- a structured installation practice;
- simple maintenance rules;
- contracting on a common basis;
- cost effectiveness in development, manufacturing, installation and operation.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

Introduction

The present document addresses earthing and bonding of data and telecom (ICT) equipment in data and telecom centres when implementing a direct current interface up to 400 VDC defined in EN 300 132-3-1 [1] in relation to safety, functional performance and EMC. The present standard may also be applicable for ICT equipment in other locations such as: street cabinets, containers, subscriber's buildings, BTSs, etc.

The general principles for electrical installations from a safety perspective are based on the HD 60364-series (IEC 60364-series) of standards, and where appropriate on information published by ITU-T to provide for the proper functioning of those installations.

1 Scope

The present document applies to earthing and bonding of ICT equipment installed in data and telecom centres and similar installations operating within the normal service voltage range up to 400 VDC defined in EN 300 132-3-1 [1].

Earthing and bonding network of the building (CBN), the bonding network of the equipment (SRPP), and the interconnection between these two networks are treated in the present document. It contributes to the standardization of telecommunication and datacom equipment installation.

It also co-ordinates with the pre-conditions of the installation to achieve the following targets:

- safety from electrical hazards;
- continuity of service requiring:
  - reliable signal reference;
  - satisfactory Electromagnetic Compatibility (EMC) performance.

The present document defines earthing and bonding configuration down to the equipment level in order to facilitate the installation, operation and maintenance of data and telecom centres in data and telecom buildings or similar installations independent of the equipment supplier.

The specification of ICT equipment and of the pre-conditions of installation is subject to agreement of the parties (e.g. the supplier and the purchaser). Annex A can be used in the procedure to achieve an agreement.

The present document does not cover safety and EMC aspects of the equipment. Those aspects are covered by other relevant standards.

The present document applies to the installation of ICT equipment in data and telecom centres. The present document may also be applicable for ICT equipment in other locations, e.g.:

- street cabinet;
- container;
- subscriber's building;
- BTS.

2 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 http://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.

2.1 Normative references

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

[1] ETSI EN 300 132-3-1: "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".

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

[3] CENELEC HD 60364-4-41: "Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock" (IEC 60364-4-41).

[4] CENELEC HD 60364-5-54: "Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements and protective conductors" (IEC 60364-5-54).

[5] IEC 60050: "International Electrotechnical Vocabulary".

[6] CENELEC EN 60950-1: "Information technology equipment - Safety - Part 1: General requirements" (IEC 60950-1).

[7] CENELEC EN 62305-series: "Protection against lightning" (IEC 62305-series).

[8] CENELEC EN 50310: "Application of equipotential bonding and earthing in buildings with information technology equipment".

[9] ETSI EN 300 253: "Environmental Engineering (EE); Earthing and bonding of telecommunication equipment in telecommunication centres".

[10] CENELEC EN 41003: "Particular safety requirements for equipment to be connected to telecommunication networks and/or a cable distribution system".

[11] IEC/TR 60479-5: "Effects of current on human beings and livestock - Part 5: Touch voltage threshold values for physiological effects".

[12] CENELEC EN 50174-2: "Information technology -Cabling installation -Part 2: Installation planning and practices inside buildings".

[13] CENELEC EN 61557-8: "Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. - Equipment for testing, measuring or monitoring of protective measures - Part 8: Insulation monitoring devices for IT systems" (IEC 61557-8).

[14] CENELEC EN 61557-9: "Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. - Equipment for testing, measuring or monitoring of protective measures - Part 9: Equipment for insulation fault location in IT systems" (IEC 61557-9).

[15] CENELEC HD 308: "Identification of cores in cables and flexible cords".

[16] CENELEC EN 60445: "Basic and safety principles for man-machine interface, marking and identification - Identification of equipment terminals, conductor terminations and conductors" (IEC 60445).

2.2 Informative references

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] Recommendation ITU-T K.27: "Bonding configurations and earthing inside a telecommunication building".

[i.2] CENELEC EN 55022: "Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement".

[i.3] Recommendation ITU-T L.1200: "Specification of DC power feeding system interface".

3 Definitions and abbreviations

3.1 Definitions

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

3.1.1 IEC definitions

The following definitions (IEC reference in parentheses) with respect to earthing and bonding are introduced by the IEC 60050 [5] and are used within the present document to maintain conformity.

earth (195-01-03): part of the Earth which is in electric contact with an earth electrode and the electric potential of which is not necessarily equal to zero earthing arrangement

earthing conductor (195-02-03): conductor which provides a conductive path, or part of the conductive path, between a given point in a system or in an installation or in equipment and an earth electrode

earth electrode (195-02-01): conductive part, which may be embedded in a specific conductive medium, e.g. concrete or coke, in electric contact with the Earth

earthing network (604-04-07): part of an earthing installation that is restricted to the earth electrodes and their interconnections

equipotential bonding (195-01-10): provision of electric connections between conductive parts, intended to achieve equipotentiality

exposed-conductive-part (826-12-10): conductive part of equipment which can be touched and which is not normally live, but which can become live when basic insulation fails

extraneous-conductive-parts (195-06-11): conductive part not forming part of the electrical installation and liable to introduce an electric potential, generally the electric potential of a local earth

functional-equipotential-bonding (826-13-21): equipotential bonding for operational reasons other than safety

insulation monitoring device (IMD): an IMD for IT systems defined in HD 60364-series gives a warning if the insulation resistance R_F (including the insulation resistance of all the connected appliances) between the system live conductors and earth falls below a predetermined level (response value R_a). See EN 61557-8 [13]

line conductor (826-14-09): 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

live part (826-12-08): conductor or conductive part intended to be energized in normal operation, including a neutral conductor, but by convention not a PEN conductor or PEM conductor or PEL conductor

main earthing terminal (826-13-15): terminal or busbar which is part of the earthing arrangement of an installation and enabling the electric connection of a number of conductors for earthing purposes

mid-point (MP) (826-14-04): common point between two symmetrical circuit elements whose opposite ends are electrically connected to different line conductors of the same circuit

NOTE: MP is an abbreviation for "mid-point" defined and used in the present document.

mid-point conductor (M) (826-14-08): conductor electrically connected to the mid-point and capable of contributing to the distribution of electric energy

neutral conductor (N) (826-01-03): conductor connected to the neutral point of a system and capable of contributing to the transmission of electrical energy

PEL conductor (826-13-27): conductor combining the functions of both a protective earthing conductor and a line conductor

PEM conductor (826-13-26): conductor combining the functions of both a protective earthing conductor and a mid-point conductor

PEN conductor (826-13-25): conductor combining the functions of both a protective earthing conductor and a neutral conductor

protective bonding conductor (195-02-10): protective conductor provided for protective-equipotential-bonding

protective earthing conductor (PE) (826-13-23): protective conductor provided for protective earthing

protective-equipotential-bonding (826-13-20): equipotential bonding for the purposes of safety

residual current device (RCD) (442-05-02): mechanical switching device designed to make, carry and break currents under normal service conditions and to cause the opening of the contacts when the residual current attains a given value under specified conditions

IT, TN-C, TN-S, and TT systems (see HD 60364-1 [2]): The codes used have the following meanings:
First letter – Relationship of the power system to earth:
T = direct connection of one point to earth;
I = all live parts isolated from earth, or one point connected to earth through a high impedance.
Second letter – Relationship of the exposed-conductive-parts of the installation to earth:
T = direct electrical connection of exposed-conductive-parts to earth, independently of the earthing of any point of the power system;
N = direct electrical connection of the exposed-conductive-parts to the earthed point of the power system
Subsequent letter(s) (if any) – Arrangement of neutral and protective conductors:
S = protective function provided by a conductor separate from the neutral conductor or from the earthed line conductor.
C = neutral and protective functions combined in a single conductor (PEN conductor).

3.1.2 Other definitions

The following definitions, specific to telecommunication installations and not covered by the IEC 60050 [5], are used within the present document. Correspondence to Recommendation ITU-T K.27 [i.1] and ETSI are indicated where appropriate.

bonding mat: essential means to provide a SRPP by a discernible, nearly regular mesh structure

NOTE: The bonding mat may be located either below or above a collection of equipment constituting a system block.

Bonding Network (BN), (Recommendation ITU-T K.27 [i.1]): set of interconnected conductive structures that provides an "electromagnetic shield" for electronic systems and personnel at frequencies from Direct Current (DC) to low Radio Frequency (RF)

NOTE: The term "electromagnetic shield" denotes any structure used to divert, block or impede the passage of electromagnetic energy. In general, a BN need not be connected to earth but all BNs considered in the present document will have an earth connection.

Common Bonding Network (CBN), (Recommendation ITU-T K.27 [i.1]): principal means for effective bonding and earthing inside a telecommunication building

NOTE: It is the set of metallic components that are intentionally or incidentally interconnected to form the principal BN in a building. These components include: structural steel or reinforcing rods, metallic plumbing, Alternating Current (AC) power conduit, PE conductors, cable racks and bonding conductors. The CBN always has a mesh topology and is connected to the earthing network.

DC return conductor: (L-) conductor of the +400 VDC secondary DC supply and (L+) conductor of the -48 V or -60 V secondary DC supply

NOTE: The DC conductor may or may not be connected to earth.

Isolated Bonding Network (IBN): bonding network that has a single point of connection ("SPC") to either the common bonding network or another isolated bonding network

NOTE: All IBNs considered here will have a connection to earth via the SPC.

ICT equipment: equipment designed for Information and Communication Technologies

NOTE: It is similar to Information Technology (IT), but focuses primarily on communication technologies. This includes the Internet, wireless networks, cell phones, and other communication mediums.

MESHed Bonding Network (MESH-BN), (Recommendation ITU-T K.27 [i.1]): bonding network in which all associated equipment frames, racks and cabinets and usually the DC power return conductor, are bonded together as well as at multiple points to the CBN

NOTE 1: Consequently, the MESH-BN augments the CBN.

NOTE 2: See Figure 1 of the present document.

MESHed Isolated Bonding Network (MESH-IBN), (Recommendation ITU-T K.27 [i.1]): type of IBN in which the components of the IBN (e.g. equipment frames) are interconnected to form a mesh-like structure

NOTE: This may, for example, be achieved by multiple interconnections between cabinet rows, or by connecting all equipment frames to a metallic grid (a "bonding mat") extending beneath the equipment. The bonding mat is, of course, insulated from the adjacent CBN. If necessary the bonding mat could include vertical extensions, resulting in an approximation to a Faraday cage. The spacing of the grid is chosen according to the frequency range of the electromagnetic environment.

normal service voltage range: range of the steady-state voltage at the A3 interface over which the equipment will maintain normal service

NOTE: A3 as defined in EN 300 132-3-1 [1].

power supply:

- **primary supply:** public mains or, under emergency conditions, a locally generated AC supply
- **secondary supply:** supply to the ICT equipment, racks or system block, derived from the primary supply
- **tertiary supplies:** supplies to the ICT equipment, derived from the secondary supply

system: regularly interacting or interdependent group of items forming a unified whole

system block: functional group of equipment depending in its operation and performance on its connection to the same system reference potential plane, inherent to a MESH-BN

System Reference Potential Plane (SRPP): conductive solid plane, as an ideal goal in potential equalizing, is approached in practice by horizontal or vertical meshes

NOTE 1: The mesh width thereof is adapted to the frequency range to be considered. Horizontal and vertical meshes may be interconnected to form a grid structure approximating to a Faraday cage.

NOTE 2: The SRPP facilitates signalling with reference to a common potential.

3.2 Abbreviations

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

AC	Alternating Current
BN	Bonding Network
BTS	Base Transceiver Station
CB	Circuit Breaker
CBN	Common Bonding Network
CM	Common Mode
DC	Direct Current
DC-C	Common DC return (2-wire)
DC-I	Isolated DC return (3-wire)
EMC	ElectroMagnetic Compatibility
IBN	Isolated Bonding Network
ICT	Information and Communication Technology
IEC	International Electrotechnical Commission

IMD	Insulation Monitoring Device
IT	See clause 3.1.1.
ITU-T	International Telecommunication Union-Telecommunication
LPS	Lightning Protection System
M	Mid-point conductor
MESH-BN	MESHed Bonding Network
MESH-IBN	MESHed Isolated Bonding Network
MET	Main Earthing Terminal
MP	Mid-Point
N	Neutral conductor
PE	Protective Earthing conductor
PEL	combined Protective Earthing conductor and Line conductor
PELV	Protective Extra Low Voltage
PEM	combined Protective Earthing conductor and Mid-point conductor
PEN	combined Protective Earthing conductor and Neutral conductor
RCD	Residual Current Device
RF	Radio Frequency
SELV	Safety Extra Low Voltage
SRPP	System Reference Potential Plane
TN	See clause 3.1.1.
TN-C	See clause 3.1.1.
TN-S	See clause 3.1.1.
TT	See clause 3.1.1.
VAC	Volts Alternating Current
VDC	Volts Direct Current

4 General requirements

The earthing and bonding arrangements for 400 VDC interface A3 (stipulated in EN 300 132-3-1 [1]) treated in the present document are intended to be implemented on new sites as well as on existing sites.

NOTE 1: The interface A3 is equivalent to the interface P in Recommendation ITU-T L.1200 [i.3].

The earthing and bonding arrangements for 400 VDC interface A3 are intended to co-exist with the earthing and bonding arrangements according to EN 300 253 [9] valid for -48 VDC interface A and according to EN 50310 [8] valid for ICT equipment powered by 230 VAC, without any adverse effects on safety and continuity of service.

NOTE 2: If no specific voltage is stated in connection to expressions like "ICT equipment", "ICT system", etc. in the text below, the normal service voltage range for interface A3 is presumed as defined in EN 300 132-3-1 [1].

4.1 Safety from electrical hazards

HD 60364-series of standards lay down the rules for the design, erection, and verification of electrical installations. These standards shall be complied with to provide for safety of persons and property against dangers and damage which may arise in the electrical installations and to provide for the proper functioning of those installations.

The installation material involved shall provide sufficiently high voltage, current, temperature ratings according to the relevant safety standards to avoid electric shock, risk of fire, or damage to the equipment under normal or faulty operating conditions within an equipment or the distribution network, or due to the impact of induced voltage and current, e.g. by lightning.

The design of ICT equipment shall meet relevant product standard such as EN 60950-1 [6] and EN 41003 [10].

- For safety reasons all exposed-conductive-parts (e.g. equipment chassis) of 400 VDC ICT equipment (class I) shall be provided with a protective earthing conductor (PE).

Class II equipment with conductive chassis shall either be galvanically isolated from the chassis of class I equipment or be provided with a protective earthing conductor (PE). For these reasons only ICT equipment of type "class I" are recommended and presumed for the earthing arrangement presented in the present document.