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Foreword

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Modal verbs terminology

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1 Scope

The present document describes the principles for powering of Telecommunications Equipment (TE) in access networks (both traditional copper based and Next Generation fibre and/or hybrid based) and contains requirements for the powering systems, laying down:

- the characteristics of the input and output interfaces of the power units; the recommendations for TE power protection, also regarding network integrity and public services availability requirements;
- the management data, necessary to guarantee the required availability of the network and provided public services and to ensure the maintenance of the TE power units.

The present document takes into account the innovative characteristics of fibre-based access network equipment, for which the intrinsic limitation of the local power plants should be considered regarding the equipment installed inside telecom centre or local exchanges or installed in streets or inside buildings: it goes from "complete integration of the power plant in the TE" to "remote power feeding from a distant power plant".

The present document provides detailed information in annex A on the improved reliability of public electric power grid and on the improved reliability and availability of new fibre-based NGA network. It should be considered that, for street cabinet TE, the local power scenario is common and, in that case, the main power supply availability characteristics are mainly based on electrical energy provider's performance.

The present document applies to the powering of all equipment of the access network (copper, fibre or radio networks) located inside or outside telecommunications centres or local exchanges, differentiating the applicable and sustainable power protection requirements. The access network is defined as the part of the telecommunications network, which comprises the network termination (passive or active) that is installed inside customer premises and the first exchange that can be also the broadband local exchange.

As innovative fibre-based and hybrid-based NGA network TE are changing the traditional powering paradigm, the present document proposes the viable measures to comply with the integrity, availability and uninterrupted telephone/VoIP provision that European regulatory defines for public networks [i.18].

The present document describes different configurations of powering the TE and the impacts on networks and services continuity and reliability:

- Local power supply for TE (e.g. street cabinet, active network termination, etc.).
- Remote Feeding to TE from central office through copper access pair.
- Cluster Power supply feeding power for a cluster of TE.
- Remote power feeding to TE from centre or cluster power through a power cable.
- Back feeding or Reverse Powering architecture that can supply power to Access Network Units such as ONU or ONT or remote DSL unit from the customer premises through its final distribution access copper pair.

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] ETSI EN 300 132-1: "Environmental Engineering (EE); Power supply interface at the input to Information and Communication Technology (ICT) equipment; Part 1: Alternating Current (AC)".

[2] ETSI EN 300 132-2: "Environmental Engineering (EE); Power supply interface at the input of Information and Communication Technology (ICT) equipment; Part 2: -48 V Direct Current (DC)".

[3] IEC 62368-3: "Audio/video, information and communication technology equipment - Part 3: Safety aspects for DC power transfer through communication cables and ports".

[4] EN 60038: "CENELEC standard Voltages", (produced by CENELEC).

[5] EN 60664-1: "Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests", (produced by CENELEC).

[6] EN 50310: "Application of equipotential bonding and earthing in buildings with information technology equipment", (produced by CENELEC).

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

[8] Recommendation ITU-T K.35: "Bonding configurations and earthing at remote electronic sites".

[9] Recommendation ITU-T K.45: "Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltages and overcurrents".

[10] ETSI ES 203 215: "Environmental Engineering (EE); Measurement Methods and Limits for Power Consumption in Broadband Telecommunication Networks Equipment".

[11] ETSI EN 300 132-3: "Environmental Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 3: Operated by rectified current source, alternating current source or direct current source up to 400 V".

NOTE: A revision is on-going in ETSI and this document should become ETSI EN 300 132-3-1: "Direct current source up to 400 V".

[12] ETSI ES 202 336-1: "Environmental Engineering (EE); Monitoring and Control Interface for Infrastructure Equipment (Power, Cooling and Building Environment Systems used in Telecommunication Networks); Part 1: Generic Interface".

[13] ETSI TS 101 548-1: "Access, Terminals, Transmission and Multiplexing (ATTM); European Requirements for Reverse Powering of Remote Access Equipment; Part 1: Twisted pair networks".

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

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

[16] HD 60364 series: "Low Voltage electrical installations material", produced by CENELEC.

[17] ETSI ES 202 336-8: "Environmental Engineering (EE); Monitoring and Control Interface for Infrastructure Equipment (Power, Cooling and Building Environment Systems used in Telecommunication Networks); Part 8: Remote Power Feeding System control and monitoring information model".

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 300 019-1-1: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-1: Classification of environmental conditions; Storage".

[i.2] ETSI EN 300 019-1-3: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weather protected locations".

[i.3] ETSI EN 300 019-1-4: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-4: Classification of environmental conditions; Stationary use at non-weather protected locations".

[i.4] ETSI EN 300 019-1-8: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-8: Classification of environmental conditions; Stationary use at underground locations".

[i.5] Void.

[i.6] Void.

[i.7] HD 60364-1: "Low-voltage electrical installations - Part 1: Fundamental principles, assessment of general characteristics, definitions", (produced by CENELEC).

[i.8] ETSI EN 302 999: "Safety; Remote Power Feeding Installations; Safety requirements for the erection and operation of information technology installations with remote power feeding".

[i.9] ENISA: "Power Supply Dependencies in the Electronic Communications Sector Survey, analysis and recommendations for resilience against power supply failures", December 2013.

[i.10] CEER (Council of European Energy Regulators): "Benchmarking Report 5.2 on the Continuity of Electricity Supply" - Ref: C14-EQS-62-03 (12 February 2015).

NOTE: Available at https://www.ceer.eu/documents/104400/-/-/cbc48e6a-5d5e-a170-ae1d-7b7b298d46a4.

[i.11] AEEGSI report 16th November 2015.

NOTE: Available at www.autorita.energia.it/allegati/com_stampa/15/151116cs.pdf.

[i.12] ETSI TS 103 553-1: "Environmental Engineering (EE); Innovative energy storage technology for stationary use; Part 1: Overview".

[i.13] IEC EN 60950-21: "Information technology equipment. Safety. Remote power feeding".

[i.14] IEC EN 60950-22: "Information technology equipment. Safety. Equipment installed outdoors".

[i.15] IEC EN 62368-3: "Audio/video, information and communication technology equipment - Part 3: Safety aspects for DC power transfer through communication cables and ports".

[i.16] Recommendation ITU-T L.1001: "External universal power adapter solutions for stationary information and communication technology devices".

[i.17] IEC EN 62368-1: "Audio/video, information and communication technology equipment - Part 1: Safety requirements".

[i.18] Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 as emended by Directive 2009/136/EC of the European Parliament and of The Council of 25 November 2009, in particular regarding the Article 23 provisions.

[i.19] ETSI EN 303 215 (V1.3.1) (2015-04): "Environmental Engineering (EE); Measurement methods and limits for power consumption in broadband telecommunication networks equipment".

[i.20] EN 60896-2: "Stationary lead-acid batteries - General requirements and methods of test - Part 2: Valve regulated types", (produced by CENELEC).

[i.21] TR 62102: "Electrical safety - Classification of interfaces for equipment to be connected to information and communications technology networks", (produced by CENELEC).

[i.22] Void.

[i.23] Recommendation ITU-T L.1220 (2017-08): "Innovative energy storage technology for stationary use - Part 1: Overview of energy storage".

[i.24] EN 60950-1: "Information technology equipment - Safety - Part 1: General requirements", (produced by CENELEC).

[i.25] Recommendation ITU-T L.1202 (2015): "Methodologies for evaluating the performance of an up to 400 VDC power feeding system and its environmental impact".

[i.26] ETSI ES 203 408 (V1.1.1) (2016-12): "Environmental Engineering (EE); Colour and marking of DC cable and connecting devices".

[i.27] Broadband Forum TR-301.

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

access network: part of a telecommunications network between the Network Termination/Access Gateway and the first switching unit

backfeeding or reverse powering: powering architecture that can supply power to access network units from the customer through its final distribution access copper pair

NOTE: Access network units may be ONU, ONT or remote DSL units.

centralized powering: remote powering in which the remote feeding source is located in a telecommunications centre

cluster powering: remote powering of a cluster of equipment (1 to n items of equipment), in which the remote feeding source is located outside a telecommunications centre

electric energy provider: provider of electrical energy from the public grid (mains)

ES1, ES2, ES3: See IEC EN 62368-1 [i.17].

interface A: -48 V power interface at input of Telecom/ICT equipment with voltage range and other electrical specifications defined in ETSI EN 300 132-2 [2]

interface A1: up to 400 VAC rms power interface at input of Telecom/ICT equipment with voltage range and other electrical specifications defined in ETSI EN 300 132-1 [1]

interface A3: up to 400 VDC power interface at input of Telecom/ICT equipment with voltage range, and other electrical specifications defined in ETSI EN 300 132-3 [11]

Local Power Unit (LPU): power supply equipment whose function is to supply a telecommunication equipment situated at the same location

NOTE: It is generally locally connected to the mains and provides DC or AC voltage output to feed telecommunication equipment.

local powering: powering principle of a telecommunications equipment by a (dedicated) power unit implemented in the same location

primary circuit: See IEC EN 62368-1 [i.17].

protective device selectivity: coordination of the operating characteristics of two or more protective devices to ensure faulty equipment is safely disconnected with no or limited impact on other parts of the system

PS1, PS2, PS3: See IEC EN 62368-1 [i.17].

Remote Feeding Telecommunication (RFT) circuit: secondary circuit within the equipment, intended to supply or receive DC power via a telecommunication network at voltages equal to or exceeding the limits for TNV circuits, and on which overvoltages from telecommunication networks are possible

Remote Power Unit (RPU): unit, powered by the grid or by a DC power system delivering -48 V or up to 400 VDC, which supplies remote DC on power lines to distant Telecommunication Equipment (TE) e.g. radio unit or RPR

Remote Power Receiver (RPR): unit receiving remote DC from RPU though power lines and converting it to input power interface of a TE or a radio unit

NOTE: The RPR may be an external unit with an adapted power interface (e.g. -48 V) or an integrated function of a telecommunications equipment.

Remote Powering (RP): power feeding of a telecommunications equipment by a remote power circuit

NOTE: Such a circuit consists of a remote power unit, distribution wiring, and fed receivers.

RFT-C circuit: RFT circuit which is so designed and protected that under normal operating conditions and single fault conditions the currents in the circuit do not exceed defined values

RFT-V circuit: RFT circuit which is so designed and protected that under normal operating conditions and single fault conditions the voltages are limited and the accessible area of contact is limited

secondary circuit: See IEC EN 62368-1 [i.17].

SELV circuit: See EN 60950-1 [i.24].

TLC network and service provider: provider of telecommunications network services

TN-C: See HD 60364-1 [i.7].

TN-S: See HD 60364-1 [i.7].

TNV circuit: See EN 60950-1 [i.24].

TT: See HD 60364-1 [i.7].

3.2 Symbols

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

I_1, I_2 I_3, I_4 I_5, I_6,	power interface
L-	Power line of negative potential polarity
L+	Power line of positive potential polarity
S	Signal
S/P_{filter}	Filter separating signal S and power P

3.3 Abbreviations

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

A_{bat}	Autonomy of a battery
AC	Alternating Current
AN	Access Node
ANU	Access Network Unit
B	Battery
CB	Circuit Breaker
CO	Central Office
CPE	Customer's Premises Equipment
DC	Direct Current
DC/DC	Direct Current/Direct Current

NOTE: DC/DC are used in general in expression such as DC/DC converter or DC/DC conversion.

DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Module
EC_{bat}	Energy Capacity of a battery
EMC	ElectroMagnetic Compatibility
FTTB	Fibre To The Building
FTTC	Fibre To The Curb
FTTCab	Fibre To The Cabinet
FTTdp	Fibre To The distribution point
FTTH	Fibre To The Home
HD	Harmonization Document
HTA	Home Terminal Adaptor
ICT	Information & Communication Technology
IEC	International Electrical Committee
ISDN	Integrated Services Digital Network
IT	Information Technology
ITU-T	International Telecommunication Union - Telecommunication standardization sector
LED	Light Emitting Diode
LPU	Local Power Unit
LV	Low Voltage
MDF	Main Distribution Frame
MP	Mid-Point
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
NGA	Next Generation Access
ONT	Optical Network Termination
ONU	Optical Network Unit
P	Power

NOTE: Indices can be used associated with P as P_{indice} in some clauses to clarify which power P is used in formula.

PD	Powered Device
PG	Power Gathering
PM	Powering Method
POTS	Plain Old Telephone Service
PSE	Power Sourcing Equipment
PSTN	Public Switched Telephone Network
PSU	Power Supply Unit
R	Rectifier
RFT	Remote Feeding Telecommunication
RFT-C	Remote Feeding Telecommunication-Current
RFT-V	Remote Feeding Telecommunication-Voltage
RP	Remote Power
RPF	Remote Power Feeding
RPR	Remote Power Receiver

RPU	Remote Power Unit
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SELV	Safety Extra Low Voltage
S/P	Signal/Power
TC	Telecommunication Centre
TE	Telecom Equipment
TLC	TeLecommuniCation
TNV	Telecommunication Network Voltage
UPS	Uninterruptible Power Supply
VRLA	Valve Regulated Lead Acid
Vrms	Volt root mean square

4 Powering configurations

4.0 General

Next Generation Access (NGA) networks induce changes in the powering model and in the need of local back-up, when compared to traditional access networks centre where the back-up is obtained by battery alone or with back-up generator source (Diesel, fuel cell).

Both fixed and mobile NGA networks, usually, require local powering of access network active equipment that are installed outside Central Offices and closer to the end users premises, Typical NGA scenarios are fiber-based FTTH, hybrid FTTC/FTTCab, FTTdp and FTTB architectures.

The new local powering scenario of fibre-based or hybrid fibre/copper NGA networks of a public Telecom networks and services provider, shall include back-up measures in order to ensure to comply with continuity, availability and reliability requirements defined by European regulation [i.18]. But for FTTB, FTTC/FTTCab, FTTdp with the increasing deployment of a great number of distributed active small cabinets, that can be installed inside buildings (FTTB) or in the street (FTTC, FTTCab), the basic power supply backup autonomy has to be optimized, due to a large number of small active cabinets to be installed at optimized costs and dimensions. Only when it's required for some service offers, a long back-up autonomy is obtained by local battery extension or alternatively by remote powering solution proposed to avoid local energy storage.

When a back-up is required, for defining its autonomy and its technology, the global availability and reliability of NGA networks and the AC mains failure rate and availability are considered. In fact, AC mains statistical analysis have shown in years 2000 to 2015 improvements of availability in many European countries. The NGA equipment availability have also been improved compared to the traditional network technologies, as a result, the general availability of access network is improved even with very limited or no local back-up (see annex A).

These considerations also apply to active Network Terminations like routers and/or VoIP access gateway installed and powered inside end users' premises (or inside end users' building).

Electrical energy providers have responsibility for electricity continuity and performances are reported for example in [i.10] and [i.11]. The failures and blackout risks apply to all energy customers included TLC providers. This influences the main characteristic features of the different powering architectures of access network equipment including two very important items:

- The point of connection to electric grid because the active TE of the NGA networks are changing in location. In TLC site they are powered by TLC connection to grid. When distributed they can be remotely DC powered from a TLC site connected to the grid. NGA equipment can also be local Network Terminations and Access Gateway, e.g. CPE installed inside an end users' premises powered by himself or at a short distance also powered by the customer by using a reverse powering solution.

- The responsibility and location for power back-up when it can be provided. The entity that is in charge can be electrical energy providers, TLC network and service providers or end users. The location can be inside big cabinet, Telecom Central Office, broadband local exchange etc. For NGA active street cabinets, in particular in the case of a large number of small street cabinets, battery backup are not mandatory.

As a consequence the definition of the optimal powering and back-up of equipment of the access network needs to consider three main parts:

1) the Telecommunication Centre (TC) including local exchange site (e.g. broadband access node);

2) the access network (the area between the Telecom Centre or local exchange and the Customer's Premises);

3) the Customer's Premises Equipment (CPE).

Powering architectures

Active equipment of access networks can be powered:

- remotely from a telecommunications centre (centralized powering);
- from a power supply node (cluster powering);
- locally from the mains (local powering);
- from renewable sources (PV, wind, etc.).

NOTE: Any of the three main powering architectures preferably may be combined with renewable energy sources, such as solar panels.

Inside these three main powering architectures, several configurations of powering are used. They are summarized in the clauses from 4.1 to 4.2 and in the figures 1, 2 and 3 by the acronyms PM1 to PM 10 (for powering).

Power back-up

Today, innovative NGA networks are based on grid local powering and/or end users provided local powering (home power or reverse powering solution) DC remote powering is used as an alternative to avoid local energy storage when required.

The powering availability, continuity and reliability performance are in principle based on the performance that electrical energy providers are able to assure, also complying with energy regulation requirements as big local battery are not practicable and is not required. Considering this short back-up, in annex A, a medium availability and reliability performance for NGA networks, including the grid power supply continuity statistical component, is illustrated: fibre-based NGA networks have better reliability performance then traditional copper based networks, even including electricity blackout condition component. Further improvement of the grid power supply continuity by electricity providers could be appropriate also to better protect NGA equipment.

For service, which needs to provide an available service even in the case of a mains outage, a power back-up unit can be located either in the remote power source or in the equipment powered.

For NGA networks cabinets, service providers may provide protection for grid power supply fluctuation, micro-interruptions and short interruptions (e.g. of order of seconds or minutes).

Regarding power backup for big site (e.g. Central Office) or for local exchange site, clauses 4.1 to 4.2 detail the different installation configurations.

Location of the Telecom Equipment (TE)

On the figures 1, 2 and 3 of the following clauses, the TE in access network is schematically represented in the field. These figures mean that the TE can be implemented in different types of locations:

- in a customer's Premises;
- in a building, public or private;
- in an indoor cabinet;
- in a street cabinet;
- on a pole or tower or street lamp;
- in a telecommunications manhole, etc.