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Measurement methods and limits for power consumption in broadband telecommunication networks equipment

Reference

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Contents

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Foreword

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

National transposition dates	
Date of adoption of this EN:	6 April 2015
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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 defines the energy consumption metrics and measurement methods for fixed broadband telecommunication network equipment.

1 Scope

The present document defines the power consumption metrics, the methodology and the test conditions to measure the power consumption of broadband fixed telecommunication networks equipment. The present document does not cover all possible configuration of equipment but only homogenous configurations.

The types of broadband access technologies covered by the present document are the ones widely deployed at the date of publication. Currently, the present document considers DSLAM DSL, MSAN, GPON OLT and Point to Point OLT equipment. Other access technologies may be included in further versions of the present document.

The present document also considers measurement methodology for VDSL2 equipment with vectoring functionality.

In addition to the full power state, power-saving states as defined in DSL standards [i.1] and [i.2] are also covered.

The present document focuses on Network Equipment. The end-user equipment will be handled in another 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 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.

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

[1] ETSI TS 101 388: "Access Terminals Transmission and Multiplexing (ATTM); Access transmission systems on metallic access cables; Asymmetric Digital Subscriber Line (ADSL) - European specific requirements [ITU-T Recommendation G.992.1 modified]".

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

[3] ETSI TS 101 271 (V1.1.1): "Access Terminals Transmission and Multiplexing (ATTM); Access transmission system on metallic pairs; Very High Speed digital subscriber line system (VDSL2); [ITU-T Recommendation G.993.2 modified]".

[4] Void.

[5] ETSI ES 201 970: "Access and Terminals (AT); Public Switched Telephone Network (PSTN); Harmonized specification of physical and electrical characteristics at a 2-wire analogue presented Network Termination Point (NTP)".

[6] Recommendation ITU-T G.984: "Gigabit-capable passive optical networks (GPON)".

[7] Recommendation ITU-T G.984.2: "Gigabit-capable Passive Optical Networks (G-PON): Physical Media Dependent (PMD) layer specification".

[8] IEEE 802.3: "IEEE Standard for Information technology -- Telecommunications and information exchange between systems --Local and metropolitan area networks -- Specific requirements -- Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications".

[9] Broadband Forum TR-100: "ADSL2/ADSL2plus; Performance Test Plan".

[10] Broadband Forum TR-114: "VDSL2 Performance Test Plan".

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] Recommendation ITU-T G.992.3 (2005): "Asymmetric digital subscriber line transceivers 2 (ADSL2)".

[i.2] Recommendation ITU-T G.992.5 (2005): "Asymmetric Digital Subscriber Line (ADSL) transceivers - Extended bandwidth ADSL2 (ADSL2plus)".

[i.3] Recommendation ITU-T G.993.2 (2006): "Very high speed digital subscriber line 2 (VDSL2)".

[i.4] ETSI TR 102 530: "Environmental Engineering (EE); The reduction of energy consumption in telecommunications equipment and related infrastructure".

[i.5] Broadband Forum TR-202: "ADSL2/ADSL2plus Low-Power Mode Guidelines".

[i.6] Void.

[i.7] IEC 60050: "International Electrotechnical Vocabulary - Electrical and electronic measurements and measuring instruments - Part 311: General terms relating to measurements - Part 312: General terms relating to electrical measurements - Part 313: Types of electrical measuring instruments - Part 314: Specific terms according to the type of instrument".

NOTE: Available at http://webstore.iec.ch/webstore/webstore.nsf/artnum/027448!opendocument.

[i.8] IEC 62018: "Power consumption of information technology equipment - Measurement methods".

NOTE: Equivalent to CENELEC EN 62018.

3 Definitions and abbreviations

3.1 Definitions

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

accuracy (of a measuring instrument): quality which characterizes the ability of a measuring instrument to provide an indicated value close to a true value of the measurand

NOTE 1: This term is used in the "true value" approach.

NOTE 2: Accuracy is all the better when the indicated value is closer to the corresponding true value.

NOTE 3: See IEC 60050 [i.7], definition (311-06-08).

active line: line in operational mode and carrying traffic as specified for that mode of operation (ADSL2plus or VDSL2)

broadband telecommunication network equipment: equipment of broadband technology that is part of a telecommunication network

broadband terminal equipment: equipment of broadband technology that is connected beyond the Network Termination Point of a telecommunication network

full-power state: state in which the maximal allowed data transmission is possible

NOTE: The maximum is defined by the physical properties of the line and the settings of the operator (e.g. L0 for ADSL2/2plus).

low-power state: state in which a limited power reduction capability and a limited data transmission is allowed

NOTE: It is entered automatically from the full power state after the data transmission during a certain time is lower than the limit. If more than the limited data has to be transmitted from either side a state change to the full power state is entered automatically. The low power state may comprise multiple sub-states with history dependant state transition rules (e.g. L2 for ADSL2/2plus).

power consumption: power used by a device to achieve an intended application performance

stand-by state: state in which the largest power reduction capability and no transmission of data is possible

NOTE: From this state a direct state change to the full-transmission state is possible, if data has to be transmitted from either side (e.g. L3 for ADSL2/2plus).

telecommunication network: network operated under a license granted by a national telecommunications authority, which provides telecommunications between Network Termination Points (NTPs) (i.e. excluding terminal equipment beyond the NTPs)

3.2 Abbreviations

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

AC	Alternative Current
ADSL	Asymmetric Digital Subscriber Line
ADSL2plus	Second generation ADSL with extended bandwidth
BBF	Broadband Forum
CPE	Customer Premises Equipment
DBA	Dynamic Bandwidth Allocation
DC	Directive Current
DPBO	Downstream Power Back-Off
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
DSM	Dynamic Spectrum Management
GPON	Gigabit Passive Optical Network
IP	Internet Protocol
MAC	Media Access Control
MELT	Metallic Loop Test
MIMO	Multiple Input Multiple Output
MPLS	Multiprotocol Label Switching
MSAN	Multi Service Access Node
NPC	Normalized Power Consumption
OLT	Optical Line Termination
ONU	Optical Network Unit
POTS	Plain Old Telephone Service
PSTN	Public Switched Telephone Network
QoS	Quality of Service
SNR	Signal Noise Ratio
SOHO	Small Office/Home Office
UPBO	Upstream Power Back-Off
VAC	Ventilation Air Conditioning
VDSL	Very high speed Digital Subscriber Line
VDSL2	second generation VDSL
VLAN	Virtual Local Area Network

4 Definition of power consumption

4.1 Definition of power consumption per port of broadband network equipment

The power consumption of broadband telecommunication network equipment is defined as:

$$P_{BBport} = P_{BBeq} / N_{ports}$$

Where:

$\mathbf{P_{BBeq}}$ is the power consumption (in W) of a fully equipped broadband network equipment, measured at the electric power input interface, placed at the premises of the operator or the equipment supplier, which connects multiple broadband subscribers to a backbone. P_{BBeq} is measured in determined environmental conditions defined in clause 5.1.1.

$\mathbf{P_{BBport}}$ is the power consumption per port in W of the broadband network equipment for which the limits are defined in the present document.

$\mathbf{N_{ports}}$ is the maximum number of subscriber lines access ports served by the broadband network equipment under test.

4.2 Power consumption taking into account the low-power states

The low-power states are intended to reduce the power consumption during periods of no or minimal traffic needs (e.g. low data-rate applications or control signalling only). When these low-power states are used, the achievable power consumption reduction can be estimated by using profiles based on user traffic assumptions, some example of user hourly traffic as illustrated in annex A.

NOTE 1: Example of power-saving states usage.

A number of power-saving states are defined in the DSL standards (L2, L3, Recommendations ITU-T G.992.3 [i.1] and G.992.5 [i.2]). These power-saving states are implemented, both in the Network equipment (i.e. the subject of the present document) and the CPE/end-user equipment deployed at the premises of the user of the broadband line; this will enable the operator to use these to further limit the power consumption of the equipment. Further study is required to optimize the way in which the low-power states are controlled. In particular, to determine the levels of interference that might arise due to the fluctuating crosstalk caused by frequent multi-state power transitions.

It is important to notice that it is only possible for GPON to use stand-by state if all ONU are in stand-by state and not individually as possible for Point-to-Point transmission.

NOTE 2: Additional power saving solutions. A number of additional power saving solutions are available. Some of these are listed below. However the list is not complete and both the developers and users of broadband network equipment are encouraged to investigate and introduce new power saving solutions:

- Politeness algorithms.
- Dynamic Spectrum Management.
- Boards optimized for remote applications (reduced line power).
- Dynamic power saving for unused components such as line card, chipset, port, etc.

5 Measurement methods

This clause describes the methods to measure the power consumption of broadband network equipment and also gives the conditions under which these measurements shall be performed.

5.1 General requirements

5.1.1 Measurement conditions

The power measurements shall be performed in a laboratory environment under the following conditions:

- Room Temperature: 25 °C ± 2 °C.
- Room Relative Humidity: 30 % to 75 %.
- Operating voltage:
  - DC Powered Equipment: According to ETSI EN 300 132-2 [2], -54,5 V ± 1,5 V for nominal voltage of -48 V DC powered equipment. Equipment using voltage other than -48 V DC shall be tested at ± 1 % of the nominal voltage.
  - AC Powered Equipment: 230 V ± 1 % for nominal voltage of 230 V AC and frequency 50 Hz ± 1 %.
- Minimum Measurement Duration: Equipment shall be allowed to stabilize to get stable power measurement. If power varies over the measurement interval time, an average of measurement shall be calculated:
  - For DSLAM equipment, wait 1 minute to settle bitswap after entering L0 mode. After entering L2 mode, wait one more minute after achieving the final trimmed power level.
  - For OLT equipment, wait till OLT and the connected ONUs have finished ranging and dynamic bandwidth allocation (DBA). The DBA will ensure that any unused bandwidth on a specific GPON port is allocated to the ONUs connected to it.

5.1.2 Measurement instruments requirements

All measurement instruments used should be calibrated by counterpart national metrology institute and within calibration due date:

- Power Source: Power sources used to provide power to the equipment under test shall be capable of providing a minimum of 1,5 times the power rating of the equipment under test.
- Input power:
  - Resolution: ≤ 10 mA; ≤ 100 mV; ≤ 100 mW
  - DC current: ± 1 %
  - DC voltage: ± 1 %
  - AC power: ± 1 %:
    - An available current crest factor of 5 or more
    - The test instrument shall have a bandwidth of at least 1 kHz

NOTE 1: Measurement equipment with higher digitizing rates and higher accuracy may be desirable to ensure accurate measurement.

NOTE 2: Additional information on accuracy can be found in IEC 62018 [i.8].

5.1.3 Considered equipment

The following items are considered part of the broadband network equipment and therefore their power consumption shall be taken into account to get the total power consumption (P_{BBeq}) of the broadband network equipment:

- Network Termination board, providing one or more links to the Core or Backhaul Network.

NOTE: The actual number of links should reflect the normal resilience practice for that type of equipment. Furthermore, all uplink ports should carry test traffic averaged or approximatively averaged.

- Line Termination board, providing a number of DSL, POTS, GPON or Point to Point Ethernet ports connected to the end-user through the metallic lines or optical fibre.
- Backplane (or other) to interconnect the different blocks of the broadband network equipment.
- Inside Rack Cooling system (e.g. fans drawer inside cabinet based broadband systems).
- Normal operational power supply unit.

5.1.4 Not considered equipment

The following items are not considered part of the broadband network equipment and therefore their power consumption shall not be added to the power consumption of the broadband network equipment:

- External rectifier (AC - DC converter).
- Room or outdoor Cabinet Ventilation and Air Conditioning Unit (VAC Unit).
- Auxiliary or redundant power unit.
- Battery.
- For DSLAM equipment, Additional External signal processing (Dynamic Spectrum Management (DSM) and Multiple Input Multiple Output (MIMO) techniques if not implemented as part of the Line Termination board).

For those boards which have more than the bare DSL functionality but have additional functions (e.g. MELT, vectoring, test access and channel bonding, etc.), these boards are to be used in normal DSL mode of operation with such additional functions disabled. Optionally a measurement with these functions enabled can be described/requested. In case such additional functions cannot be fully disabled, manufacturer will declare what is the extra power budget due to the added functionality. Such extra budget will not be considered in P_{BBport}.

5.1.5 Measurement reference points

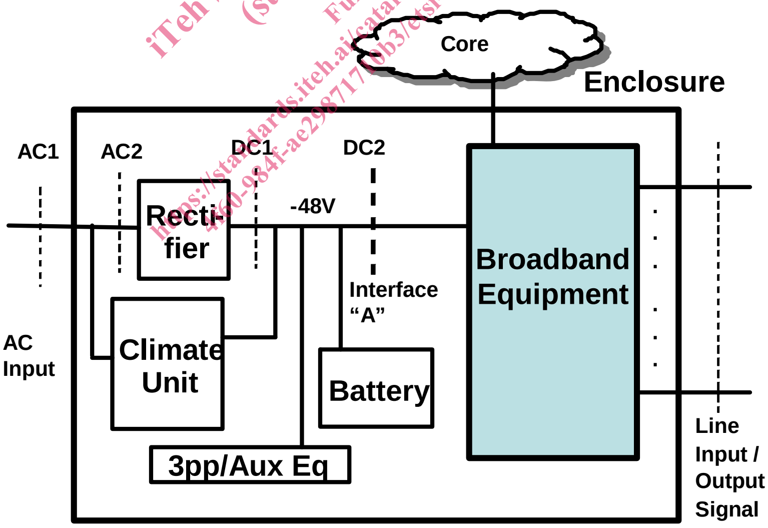

Figure 1: Broadband Node site reference model

The power consumption requirements of the present document apply at Interface "A" [2] as shown in figure 1 (i.e. at the point DC2 for the configuration in figure 1).