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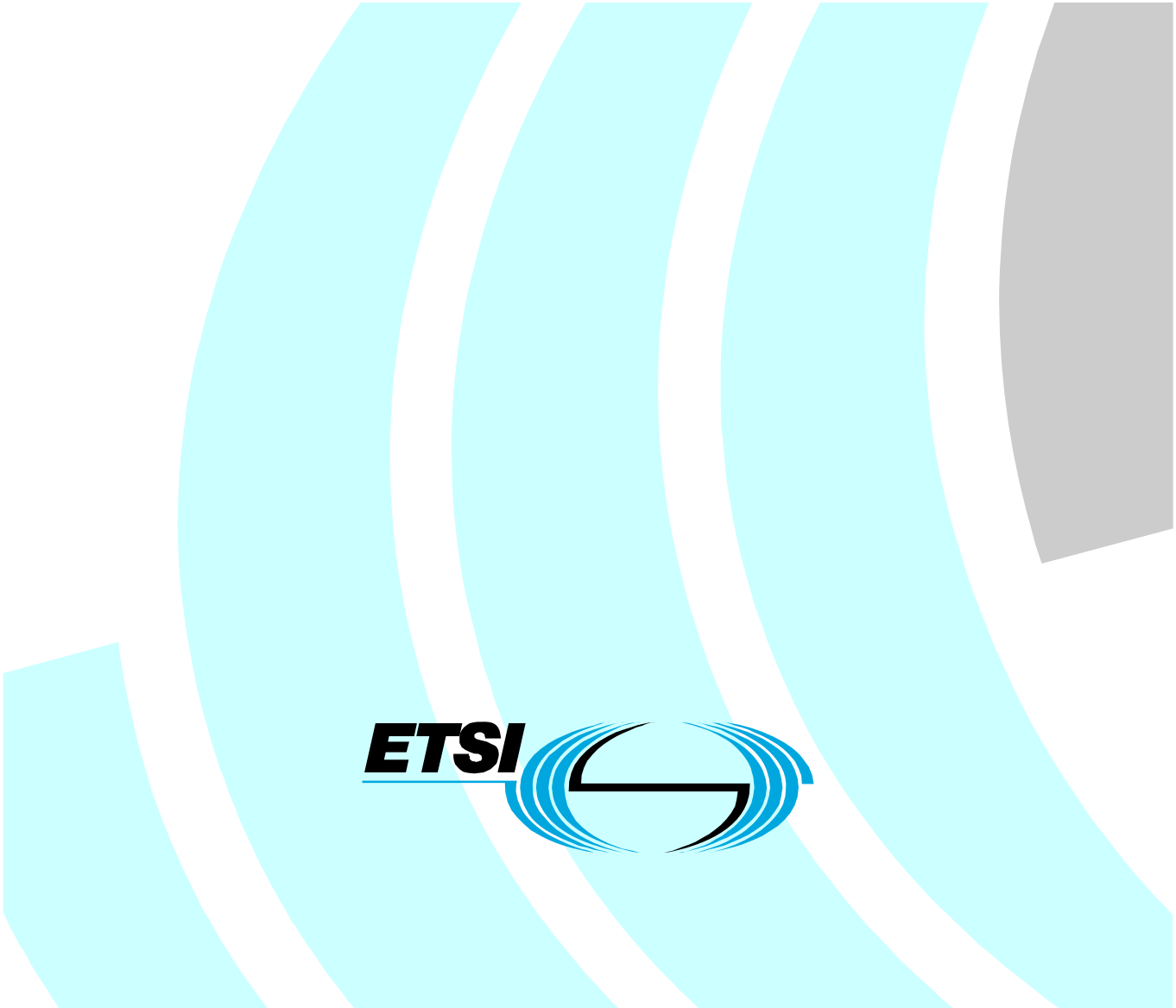
ETSI Standard

Environmental Engineering (EE); Measurement Methods and Limits for Power Consumption in Broadband Telecommunication Networks Equipment



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Contents

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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Environmental Engineering (EE), and is now submitted for the ETSI standards Membership Approval Procedure.

Introduction

The present document defines the energy consumption limits and measurement methods for fixed broadband telecommunication network equipment.

1 Scope

The present document defines the power consumption limits, the methodology and the test conditions to measure the power consumption of broadband fixed telecommunication networks equipment.

The power consumption limits are mostly in line with the European Code of Conduct for Broadband Equipment version 3 [i.1] but also made some extension on power targets roadmap.

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, Point to Point OLT equipment. Other access technologies may be included in further versions of the present document.

In addition to the full power state, power-saving states as defined in DSL standards [i.2] and [i.3] are also covered.

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

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 reference 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 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 equipment; Part 2: Operated by 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] IEC 60038 (Ed. 7.0): "IEC standard voltages".

[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] ITU-T Recommendation G.984: "Gigabit-capable Passive Optical Networks (GPON)".

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

[8] IEEE 802.3: "IEEE Standard for Information technology-Specific requirements -- Part 3: Carrier Sense Multiple Access with Collision Detection (CMSA/CD) Access Method and Physical Layer Specifications".

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] Code of Conduct on Energy Consumption of Broadband Communication Equipment European Commission Directorate-General, Joint Research Centre; Final v3: 18 November 2008.

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

[i.3] ITU-T Recommendation G.992.5 (2005): "Asymmetric Digital Subscriber Line (ADSL) transceivers - Extended bandwidth ADSL2 (ADSL2plus)".

[i.4] ITU-T Recommendation G.993.2 (2006): "Very high speed digital subscriber line 2 (VDSL2)".

[i.5] ETSI TR 102 530: "Environmental Engineering (EE); The reduction of energy consumption in telecommunications equipment and related infrastructure".

[i.6] Broadband Forum TR-202: "ADSL2/ADSL2plus Low-Power Mode Guidelines".

3 Definitions and abbreviations

3.1 Definitions

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

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
CPE	Customer Premises Equipment
DC	Directive Current
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
DSM	Dynamic Spectrum Management
GPON	Gigabit Passive Optical Network
IP	Internet Protocol
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
ONT	Optical Network Termination
POTS	Plain Old Telephone Service
PSTN	Public Switched Telephone Network
QoS	Quality of Service
VAC	Ventilation Air Conditioning
VDSL	Very high speed Digital Subscriber Line
VDSL2	Second generation VDSL

4 Definition of power consumption

4.1 Definition of power consumption per line of broadband network equipment

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

$$P_{BBline} = P_{BBeq} / N_{subscrib\text{-}lines}$$

Where:

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.

P_{BBline} is the power consumption per line in W of the broadband network equipment for which the limits are defined in the present document.

$N_{suscrib\text{-}lines}$ is the maximum number of subscriber lines or ports served by the broadband network equipment under test.

4.2 Definition of normalized power consumption per line for broadband network equipment

In addition to the power consumption P_{BBline} that is defined for the equipment, an indication of global network power performance "Normalized Power Consumption" (NPC) might be given. The definition of the NPC can be found in TR 102 530 [i.5].

For DSLAM equipment, the NPC is an indicator of the amount of power required to transport 1 Mbps of data over a predefined reference lengths in table 1, it is based on the bitrate and reach at full-power state as defined in the measurement method (see clause 5.2.2).

For OLT equipment, the NPC is an indicator of the amount of power required to transport 1 Mbps. Since the power consumption of OLT is not directly related with optical fibre length, no reference optical fibre length is defined.

$$NPC = 1\,000 \times \mathbf{P_{BBline}} / \text{bitrate}$$

NPC is expressed in mW/Mbps. Bitrate is the downstream net activation data rate expressed in Mbps.

This NPC enables comparison of same technologies from different equipments and/or vendors, as well as of similar technologies such as evolutions or extensions (e.g. VDSL2 Vectoring) regarding the efficiency of transporting information (in terms of power). It shall be calculated at relevant reference loop lengths for each technology, and as such it should be clear that using NPC to directly compare technologies which use different reference loops or different access technologies shall not be promoted. These reference loops are derived from the typical or targeted working conditions of these technologies and are given in the clause on measurement methods (clause 5.2.2).

NOTE: Using the NPC to compare the different working states (e.g. L0 with L2 or L3) is not recommended as the intention of some of these working states is to save energy at times of no or low-rate transmission, i.e. when there is no need to transmit high data rates.

4.3 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, as illustrated in annex C.

NOTE 1: Usage of power-saving states.

A number of power-saving states are defined in the DSL standards (L2, L3, ITU-T Recommendations G.992.3 [i.2] and G.992.5 [i.3]). These power-saving states are implemented, both in the Network equipment 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.

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).

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 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: According to IEC 60038 [4], 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 and wait until final trimmed power level is achieved in L2 mode.
  - For OLT equipment, wait till OLT and all connected ONTs finish activation procedure.

5.1.2 Measurement instruments requirements

All measurement instruments used must be calibrated by counterpart national metrology institute and within calibration due date, and the measurement tolerance must be within ± 1 %:

- 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.
- Power Measurement Instrument: Power measurement instrument (such as voltmeter and amperometer or power analyzer) shall have a resolution of 0,5 % or better. AC power measurement instrument shall have the following minimum characteristics:
  1) A minimum digitizing sample rate of 40 kHz.
  2) Input circuitry with a minimum bandwidth of 80 kHz.
  3) It shall be capable of accurate readings of waveforms having. Crest Factor up to at least 5.

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.

- Line Termination board, providing a number of xDSL, GPON or P2P Ethernet ports connected to the end-user through the metallic lines or optical fibre.

- Splitter (Low Pass Filter) function for DSLAM.
- 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).

NOTE: 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_{BBline} and NPC computation.

5.1.5 Measurement reference points

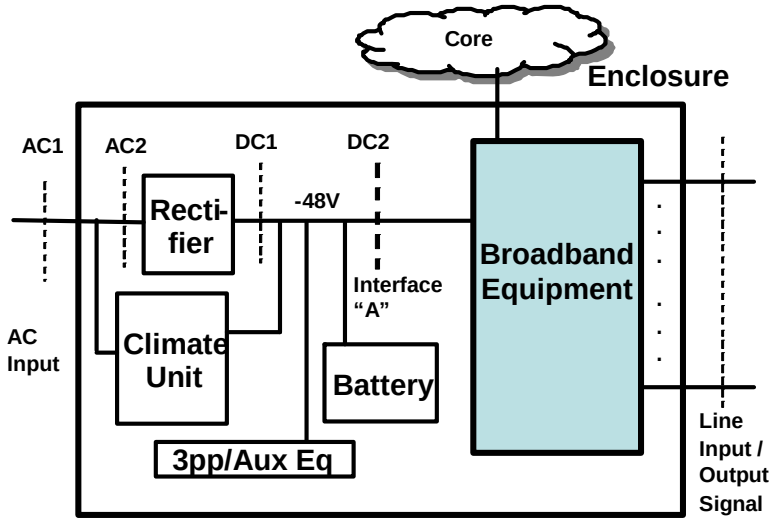

Figure 1: Broadband Node site reference model

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).

5.1.6 Traffic profile

Definition of Ethernet traffic:

- Bridge mode.
- Random variable packet size distribution from 64 octets to 1 514 octets (bytes).
- Traffic rates limited to 80 % of net activation rate (takes overhead into account).

Traffic shall flow in both directions, but due to Upstream and Downstream possible asymmetry, loop-back mode is not allowed.

5.2 Measurement method for DSLAM/MSAN equipment

5.2.1 Equipment configuration

Active lines shall be carrying traffic over an ETSI loop 1, as defined in TS 101 388 [1] and TS 101 271 [3], without any additional noise. The loop length is dependent on the xDSL technology (see ITU-T Recommendations G.992.3 [i.2], G.992.5 [i.3] and G.993.2 [i.4]) activated on the line. The test set-up is as shown in figure 2.

Equipment conditions:

- ADSL2plus configuration:
  - Loop length/type: see table 1.
  - Downstream/ Upstream data-rate: maximum possible data rate for full-power state.
  - Low power state is configured as following:
    - L0-TIME: 60 seconds.
    - L2-TIME: 15 seconds.
    - L2-ATPR: 1 dB.
    - L2-ATPRT: in the range -1 dB to -31 dB. Manufacturer shall declare the minimum L2-ATPRT value necessary to respect the requirements of table 2.

NOTE 1: L2-ATPRT parameter defines the total maximum aggregate transmit power reduction that is allowed in L2 state. As such matching L2 power consumption targets with L2 value close to -1 dB is better (higher efficient) than matching the same targets but with L2 value close to -31 dB.

    - L2-MinDatarate: $\geq$ 128 Kbps.
  - Operating Mode: Fast.
  - Target noise margin: 6 dB.
  - Line configuration: see annex A.

NOTE 2: For real network implementation a reference for the setting can be found in Broad Band forum documents TR-202 [i.6], for example L2 ATPRT $\leq$ 10 dB.

- VDSL2 configuration:
  - Loop-length/type: see table 1.
  - Downstream/ Upstream data-rate: maximum possible data rate for full-power state.
  - Operating mode: Interleaving (INP = 2, delay = 8).
  - Target noise margin: 6 dB.

- Line configuration: see annex A.

Table 1: Loop-lengths for various DSL technologies

Technology	Loop length	Reference loop
ADSL2plus	3 000 m	TS 101 388 [1], clause 5.2 loop 1 (0,4 mm)
VDSL2 profile 8a, 8b, 8c, 8d	1 500 m	TS 101 271 [3] loop 1 (0,5 mm)
VDSL2 profile 12a, 12b	1 000 m	TS 101 271 [3] loop 1 (0,5 mm)
VDSL2 profile 17a	750 m	TS 101 271 [3] loop 1 (0,5 mm)
VDSL2 profile 30a	300 m	TS 101 271 [3] loop 1 (0,5 mm)
NOTE: The above DSL technologies and profiles are defined for the power consumption measurement. Representative loop lengths for the corresponding DSL technologies and profiles are also defined in this table. The worst case VDSL2 configurations are the configurations for profile 8b and 17a. Other loop types and loop lengths may be used if resulting in the same insertion loss at 300 kHz for ADSL2plus and 1 MHz for VDSL2.		

- MSAN configuration:
  - Broadband(xDSL) circuit power consumption are as measured for the DSLAM configuration.
  - Only narrowband(voice) circuit is present in measured configuration, with POTS interfaces so configured:
    - Loop current is from min 25 mA to max 40 mA according to ES 201 970 [5] (see table 3).
    - Loop length is 3 Km of 0,4 mm gauge or a loop resistance of 510 ohm.
    - Refer to table 3 for port status.
  - Total power consumption of MSAN port (consisting of Voice and Broadband) is the sum of power consumption of the narrowband and broadband circuits.

5.2.2 Reference measurement method

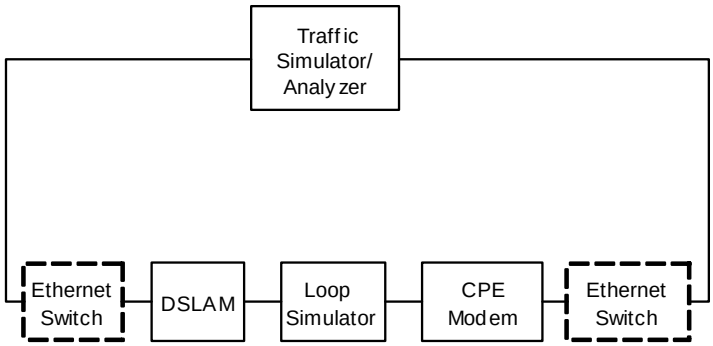

Figure 2: Test Setup for power measurement for DSLAM

Figure 2 shows the basic test setup, which is to be used during the power measurements. Both the network side (optionally through an Ethernet switch) and the end-user side (direct or also through an Ethernet switch) are connected to an Ethernet Traffic Simulator/Analyzer.

For the reference measurement method, the broadband network loop simulator should be a cable with length in line with the requirements shown in table 1 or an artificial line simulator giving the same insertion loss of the physical cable.

The specification of this artificial line simulator is currently under study.

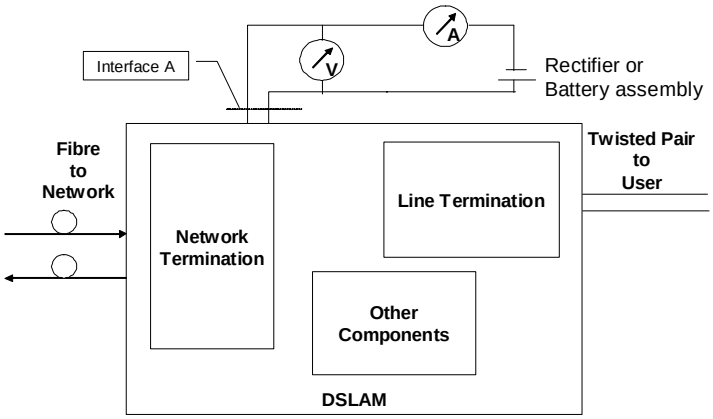

Figure 3: Power Consumption measurement at System level

In figure 3, the actual DSLAM power measurement method is shown. The DSLAM comprises the line termination boards, the Network termination boards and some other components like the cooling system. The Network termination board has fibre connections to the traffic simulator/analyzer (as shown in figures 2 and 3) and the line termination boards have twisted pairs connected to loop/line simulators.

The power consumption (P_{BBeq}) of the system under different power states (Full power state, Low power state and Standby State) is measured at the interface "A" of the DSLAM using power measurement instruments. The system can be powered either through a battery assembly or rectifier set at the nominal voltage as described in clause 5.1.1. For AC powered equipment, Real Power, Apparent Power and Power Factor should be accurately measured.

5.3 Measurement method for OLT equipment

5.3.1 Equipment configuration

OLT equipment shall be fully equipped with maximum configuration as defined below. The ports are activated and carry traffic. The test set-up is as shown in figure 4.

- GPON OLT configuration:
  - Compliance with ITU-T Recommendation G.984 [6].
  - Downstream data-rate is 2,488 Gbps and upstream data-rate is 1,244 Gbps.
  - Configured with ClassB+ (ITU-T Recommendation G.984.2 [7]) optical modules.
  - Each port of Line termination board is directly connected to ONT without splitter.
  - Typical features: standard Layer-2 (Ethernet) aggregation functionalities, MAC address management, VLAN management, Multicast. For equipment with network layer functionalities, other features including static and dynamic routing protocols, MPLS, IP QoS.
- P2P OLT configuration:
  - Point to point OLT is directly connected to Customer Premises Equipment without cascading switch.
  - The optical budget for the interfaces shall be in line with IEEE 802.3 [8], clause 58 for the 100Base-LX10 and 100Base-BX10 interfaces and IEEE 802.3 [8], clause 59 for the 1000Base-LX10 and 1000Base-BX10 interfaces.
  - Typical features: Layer-2 (Ethernet) protocol management and network layer functionalities including static and dynamic routing protocols, MPLS, IP QoS.

5.3.2 Reference measurement method

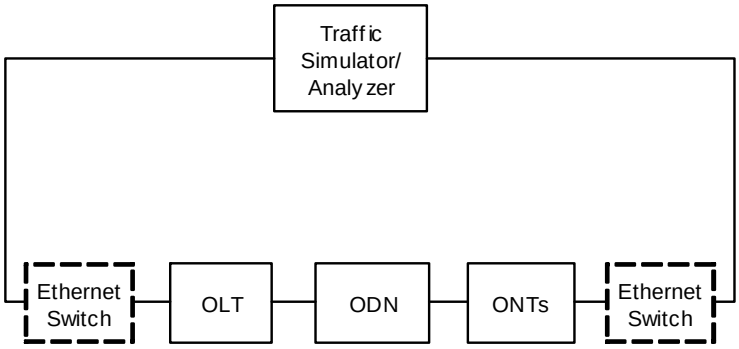

Figure 4: Test Setup for power measurement for OLT

Figure 4 shows the basic test setup, which is to be used during the power measurements. Both the network side (optionally through an Ethernet switch) and the end-user side (direct or also through an Ethernet switch) are connected to an Ethernet Traffic Simulator/Analyzer.

For the reference measurement method the broadband network equipment shall be fully equipped. All ports of the OLT shall be directly connected to ONT through optical fibre without splitter or cascading switch. The equipment is configured properly such that traffic generated by the Traffic Simulator can flow properly through the equipment to the ONT and vice versa. The Traffic Analyzer will show that the traffic is indeed passing through the setup.

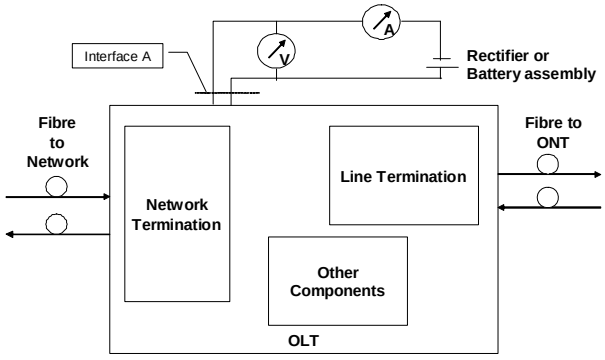

Figure 5: Power Consumption measurement at System level

In figure 5, the actual equipment power measurement method is shown. The equipment comprises the line termination boards, the Network termination boards and some other components like the cooling system. The Network termination board has fibre connections to the traffic simulator/analyzer (as shown in figures 4 and 5) and the line termination boards have fibres connected to ONT.

The power consumption (P_{BBeq}) of the system is measured at the interface "A" of the equipment using power measurement instruments. The system can be powered either through a battery assembly or rectifier set at the nominal voltage as described in clause 5.1.1. For AC powered equipment, Real Power, Apparent Power and Power Factor should be accurately measured.

5.4 Alternative measurement method

This alternative technique reduces the number of line simulators and CPE or ONT required but requires extrapolation to give the correct per line result. A minimal configuration shall include at least one fully equipped Line Termination board connected to end-user equipments and configured to pass traffic.

This alternative measurement method comprises two phases:

- The power consumption (P_{empty}) of the equipment is first measured without any Line Termination board based on figure 3 and figure 5 setup.
- In a second phase, for DSLAM, one Line Termination board is added to the system with all lines connected to a CPE though line or loop simulators. For OLT, one Line Termination board is added to the system with all lines connected to ONT through fibre. All parameters are set based on values shown in clauses 5.2.1 and 5.3.1. The power consumption ($P_{1\ line\ card}$) of the equipment with the added Line Termination board is measured once again and the difference ($P_{1\ line\ card}$ - P_{empty}) gives the power consumption ($P_{line\ card}$) of a fully equipped Line Termination board.

NOTE: During both measurements (P_{empty} and $P_{1\ line\ card}$), it is important that the functional blocks, expected to have a power consumption varying with the number of users connected, are forced in a full load condition. Functional blocks which are known to increase power consumption under heavy load are the cooling system and the Network Termination board.

The total power consumption is given by the formula:

$$P_{BBeq} = P_{empty} + n \times P_{line\ card}.$$

Where n is the maximum number of Line Termination boards per equipment.

5.5 Reporting of the measurements

The following details shall be included in the power measurement report:

- System configuration:
  - List of hardware items used in the system under test, showing both the vendor type number and serial number.
  - List of software/firmware modules used in the system.
  - The number of active line boards and ports.
  - The status and number of all end-user interfaces, including line length, line configuration and actual data rate.
- Measurement instruments:
  - List of measurement instruments used to measure the power consumption, including calibration information.
  - List of the CPE (DSL modem or ONT) used for the measurement.
- Measurement conditions:
  - Room temperature.
  - Relative humidity.
  - Actual operating voltage.
- Measurement results:
  - Power consumption: P_{BBeq}, P_{BBline}.

NOTE 1: P_{empty}, $P_{1\ line\ card}$, $P_{line\ card}$ should also be reported if the alternative measurement method defined in clause 5.4 is used.

NOTE 2: For DSLAM equipment, power consumptions should be included for different power states (Full power state, low power state, standby state).

NOTE 3: For AC powered equipment, Real Power, Apparent Power and Power Factor should be reported.

- NPC value based on the test data.

6 Power consumption limits

The additional allowance for the uplink interface is:

- 4,5 W per equipment for each Point to Point 1 000 Mbit/s interface (electrical or optical).
- 18 W per equipment for each Point to Point 10 Gbit/s interface.
- 6 W per equipment for each Point to Multipoint (GPON) interface.

In case of AC powered equipment, the power limits stated may be increased by 10 %.

In case of remote powered systems, the power limits stated may be increased by 15 %.

6.1 DSLAM power limits

The values in table 2 are for fully equipped DSLAMs with more than 100 ports. For small network equipment (up to 100 ports), where the consumption of the common parts is shared among a limited number of ports, the power consumption per port might be slightly higher than the values given below. An additional 0,3 W per line is added to the below figures with a minimum of 10 W for a complete (small) DSLAM.

Start-up/Wake-up times from Low-power-state or Stand-by state to Full-power-state should be less than 1 second. The values will be included as soon as they are defined in the corresponding standards.

Table 2: DSLAM power consumption limits per port (notes 1, 3 and 4)

	P_{BBline} (W)		
	From 1/1/2010	**From 1/1/2011 to 31/12/2012**	**After 1/1/2013**
Full power state			
ADSL2plus (19,8 dBm)	1,3	1,2	1,1
VDSL2(profile 8a)	1,9	1,7	1,55
VDSL2(profile 8b)	2,0	1,8	1,6
VDSL2(profile 8c)	1,7	1,5	1,4
VDSL2(profile 8d,12a,12b,17a)	1,8	1,6	1,5
VDSL2(profile 30a)	2,5	2,0	1,7
Low power state			
ADSL2plus	1,1	0,8	0,7
VDSL2 (note 2)	-	-	-
Standby State			
ADSL2plus	0,4	0,4	0,3
VDSL2	0,8	0,6	0,5

NOTE 1: For multi-profile boards the power consumption limits do not apply to boards profile not optimized under Energy Efficiency point of view. Equipment maker shall specify what the optimized profile for the given board under test is at which the power consumption target limit apply. For instance a board optimized for VDSL2 8b can support other profiles (e.g. 8a, 17a, 30a) but might having suboptimal performances also in terms of power consumption at such additional profiles.

NOTE 2: Low-power states are currently not defined in ITU-T Recommendation G.993.2 [i.4] (VDSL2). The target limits will be completed once they are defined in standard.

NOTE 3: The values related to 2010 and 2011 are in line with European Code of Conduct for Broadband Equipment version 3 [i.1] version 3, but the table have been extended also considering all today's available profiles, although some are not specified in the version 3 of EU CoC.

NOTE 4: Energy efficiency is often strictly related to "state of the art" technologies. As such, the values in table 2 are valid for equipments developed in the years referred in the column; as an example it is not correct applying the limits of year 2010 at an old equipment designed before 2010.

6.2 MSAN POTS power limits

Table 3: MSAN POTS power consumption limits per port (note 1)

Port State	40mA line feed (W)	32mA line feed (W)	25mA line feed (W)
Not provisioned for POTS (note 2)	0,7	0,7	0,7
Provisioned for POTS - on-hook (note 3)	0,7	0,7	0,7
Provisioned for POTS - off-hook	3,2	2,8	2,5
NOTE 1: These figures are additive to those existing in the clause 6.1 for DSLAM power limits to form the per port limit for combo operation. NOTE 2: This assumes that the port is equipped to supply POTS but has not been configured for use by an end customer. NOTE 3: This excludes any on-hook charging current, which may be drawn by the CPE (up to 3mA in some countries).			

6.3 OLT power limits

The below values are for fully equipped with maximum configuration OLTs.

Table 4: OLT power consumption limits per port

Equipment	P_{BBline} (W)		
	From 1/1/2010	From 1/1/2011 to 31/12/2012	After 1/1/2013
OLT (GPON, fully equipped with maximum configuration implementing standard Layer-2 (Ethernet) aggregation functionalities, including Multicast)	15	11	8
OLT (GPON, fully equipped with maximum configuration implementing also functionalities at the IP layer such as routing, MPLS, IP QoS)	16,5	12	9
OLT (Point to Point up to 1 000 Mbit/s, up to 100 ports, fully equipped with maximum configuration)	5	4,5	4
OLT (Point to Point up to 1 000 Mbit/s, from 100 and 300 ports, fully equipped with maximum configuration)	4	3,5	3
OLT (Point to Point up to 1 000 Mbit/s, with more than 300 ports, fully equipped with maximum configuration)	3	2,5	2
OLT (Point to Point at 10 Gbit/s, up to 12 ports, fully equipped with maximum configuration)	38	30	20
OLT (Point to Point at 10 Gbit/s, from 12 to 42 ports, fully equipped with maximum configuration)	28	20	10
OLT (Point to Point at 10 Gbit/s, with more than 42 ports, fully equipped with maximum configuration)	18	12	8

Annex A (normative): ADSL2plus/VDSL line configuration

A.1 ADSL2plus line configuration

Table A.1: Common Line settings

Parameter	Setting
PMMode	All off
DPBO	Off
RFI notches	Off
MAXSNRMds	31 dB
MAXSNRMus	31 dB
TARSNRMds	6 dB
TARSNRMus	6 dB
MINSNRMds	0 dB
MINSNRMus	0 dB
$delay\_max_n$ ds	S1 (see G.992.3 [i.2])
$delay\_max_n$ us	S1 (see G.992.3 [i.2])
INP_min_n ds	0 symbols
INP_min_n us	0 symbols
RA-Mode	AT_INIT
DS net datarate (kbit/s) (max-min)	30 000 - 128
US net datarate (kbit/s) (max-min)	4 096 - 64

A.2 VDSL2 line configuration

Table A.2: Specific line profile and limit PSD mask

Profile	Limit PSD Mask (short name)	MAXNOMATPds
8a	998-M2x-A (B8-4)	+17,5 dBm
8b	998-M2x-A (B8-4)	+20,5 dBm
8c	998-M2x-A (B8-4)	+11,5 dBm
8d	998-M2x-A (B8-4)	+14,5 dBm
12a	998-M2x-A (B8-4)	+14,5 dBm
12b	998-M2x-A (B8-4)	+14,5 dBm
17a	998E17-M2x-NUS0 (B8-8)	+14,5 dBm
30a	998E30-M2x-NUS0 (B8-13)	+14,5 dBm

Table A.3: Common Line settings

Parameter	Setting
All parameters but those specified below	Default value
Power management state forced (PMSF)	0
Power management state enabling (PMMode)	0
Loop diagnostic mode forced (LDMF)	0
Automode cold start forced	0
DPBO	Off
UPBO	Off
RFI notches	Off
MAXSNRMds	31 dB
MAXSNRMus	31 dB
TARSNRMds	6 dB
TARSNRMus	6 dB
MINSNRMds	0 dB
MINSNRMus	0 dB
$delay\_max_n$ ds	8 ms
$delay\_max_n$ us	8 ms
INP_min_n ds	2 symbols
INP_min_n us	2 symbols
RA-Mode	AT_INIT
DS net datarate (kbit/s) (max-min)	128 000 - 128
US net datarate (kbit/s) (max-min)	128 000 - 64

Annex B (informative): Example traffic profiles

The 24-hour time distribution over the states is based on the estimated typical traffic behaviour for a variety of user types.

NOTE: Further study is required to understand the effects of fluctuating crosstalk caused by systems transitioning between the L2/L3 and L0 states. This will potentially cause degradation in the performance of rate adaptive ADSL systems and therefore operators may decide to constrain the number of state transitions, which would result in a system spending longer in higher power modes.

Table B.1: Example DSLAM operational states L0-L2-L3 and 24-hour traffic model

User Type	L0 Time/Day (i.e. Full power state-time/day)	L2 Time/Day (i.e. Low power state-time/day)	L3 Time/Day (i.e. Standby state/day)
Private DSL	1 hour	1 hour	22 hours
Private triple play/SOHO	6 hours	2 hours	16 hours
Average	3,5 hours	1,5 hours	19 hours

Other traffic model, reported in table B.2, shows an alternative model with different time distribution.

Table B.2: Example DSLAM operational states L0-L2-L3 and 24-hour traffic model

User Type	L0 Time/Day (i.e. Full power state-time/day)	L2 Time/Day (i.e. Low power state-time/day)	L3 Time/Day (i.e. Standby state/day)
Private DSL	2 hours	22 hours	0
Private triple play/SOHO	8 hours	16 hours	0
Average	5 hours	19 hours	0

Annex C (informative): NPC calculation examples

NPC values are not actual requirements but informative only, and are calculated based on actual test data. Table C.1 below gives some examples for NPC calculation.

Table C.1: NPC examples calculated according to P_{BBline} values in table 2

	Data rate (Mbps)	Distance (km)	NPC (mW/Mbps)		
			2010	2011 - 2012	2013 - 2014
ADSL2plus (19,8 dBm)	5	3	260	240	220
VDSL2(profile 8b)	15	1,5	133,3	120	106,7
VDSL2(profile 12a)	20	1	90	80	75
VDSL2(profile 17a)	25	0,75	72	64	60
VDSL2(profile 30a)	55	0,3	45,5	36,4	30,9
OLT (GPON)	2 488	-	6,0	4,4	3,2
OLT (Point to Point up to 1 000 Mbps)	1 000	-	5	4,5	4

Annex D (informative): Bibliography

DSL Forum TR-067, issue 2: "Technical Report ADSL Interoperability Test Plan", (September 2006).

DSL Forum TR-100: "ADSL2/ADSL2plus; Performance Test Plan".

History

Document history			
V1.1.1	September 2010	Membership Approval Procedure	MV 20101114: 2010-09-15 to 2010-11-15