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EU Code of Conduct on Energy Consumption of Broadband Equipment

Version 6

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Title
EU Code of Conduct on Energy Consumption of Broadband Equipment Version 6

Abstract
Expectations are that broadband equipment will contribute considerably to the electricity consumption of households in European Community in the near future. Depending on the penetration level, the specifications of the equipment and the requirements of the service provider, a total European consumption of at least 50 TWh per year was estimated for the year 2015 for broadband equipment. With the general principles and actions resulting from the implementation of the Code of Conduct the electricity consumption can be slightly reduced or kept constant compared to a business as usual scenario with growing usage and penetration of broadband equipment in the EU.

The Code of Conduct sets out the power consumption levels for energy efficient broadband equipment.

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INTRODUCTION

Expectations are that broadband equipment will contribute considerably to the electricity consumption of households in European Community in the near future. Depending on the penetration level, the specifications of the equipment and the requirements of the service provider, a total European consumption of at least 50 TWh per year was estimated for the year 2015 for broadband equipment. With the general principles and actions resulting from the implementation of this Code of Conduct the (maximum) electricity consumption could be slightly reduced or kept constant compared to a business as usual scenario with growing usage and penetration of broadband equipment in the EU..[1]

The potential new electrical load represented by this equipment needs to be addressed by EU energy and environmental policies. It is important that the electrical efficiency of broadband equipment is maximised.

To help all parties to address the issue of energy efficiency whilst avoiding competitive pressures to raise energy consumption of equipment all service providers, network operators, equipment and component manufacturers are invited to sign this Code of Conduct.

This Code of Conduct sets out the basic principles to be followed by all parties involved in broadband equipment, operating in the European Community, in respect of energy efficient equipment.

[1] The article by Ward Van Heddeghem, Sofie Lambert, Bart Lannoo, Didier Colle, Mario Pickavet, Piet Demeester, "Trends in worldwide ICT electricity consumption from 2007 to 2012" [30], estimated a global consumption of communication networks in 2012 of 334 TWh. As the EU total electricity consumption is 14.3% of global energy consumption, by adopting this proportion the EU consumption of communication networks in 2012 is estimated to 47 TWh. This is a conservative estimate as the ICT consumption in the EU is representing a large share of total electricity consumption compared to other regions.

1. EQUIPMENT COVERED

This Code of Conduct covers equipment for broadband services both on the customer side as listed in Table 1, and on the network side as listed in Table 2. Note that not all the equipment listed in these tables may yet have a complete set of associated power targets. Any such missing values may be added to future versions of the Code of Conduct, as may any additional technologies that become significant in the Broadband space. Figure 1 below gives examples of home gateway/modem configurations with the boundary between customer premises and network equipment that this Code of Conduct takes into account. This Code of Conduct covers also the equipment for Small Office Home Office (SOHO) applications. Terminals like PCs or TVs are not covered by this Code of Conduct.

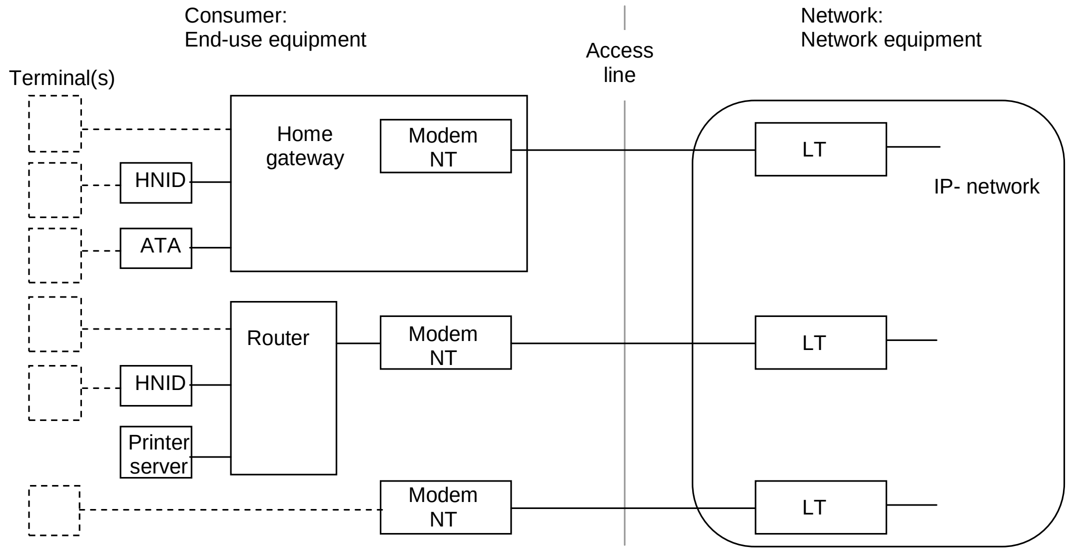

Figure 1: Examples of configurations

Broadband access equipment is defined by its incorporation of a transmission technology capable of providing more than 2048 kbit/s (ITU-T Rec I.113 [1]) full-rate capacity in at least one direction.

When equipment is in an idle state, it needs to be able to provide services with the same quality as in the on-state, or to be able transition to the on-state to deliver the service without introducing a significant additional delay from the user perspective. This requirement holds regardless of whether the service is initiated from the WAN-side, or the LAN-side.

In this Code of Conduct these categories of equipment will subsequently be referred to as "customer premises equipment" (CPE) and "network equipment" or "broadband equipment" in general.

Table 1: CPE covered

Type of CPE
Home gateways: • DSL CPEs (ADSL, ADSL2, ADSL2plus, VDSL2, VDSL2 with G.993.5 (Vectoring) support) and G.fast • DOCSIS Cable CPEs • Optical CPEs (PON and PtP) • Ethernet router CPEs

- Wireless CPEs (WiMAX, 3G, and LTE)

Simple broadband access devices:

- DSL CPEs powered by USB
- Layer 2ONUs

Home network infrastructure devices:

- Wi-Fi access points
- Small hubs and non-stackable Layer 2 switches
- Powerline adapters
- Alternative LAN technologies (HPNA and MoCA) adapters
- Optical LAN adapter

Other home network devices:

- ATA / VoIP gateway
- VoIP telephone (standalone standard desktop phone)

The following equipment is excluded from this version of the Code of Conduct:

- Terminals like PCs and TVs
- Set-top boxes for digital TV services; complex set-top boxes are covered by the Code of Conduct for digital TV Service Systems.
- Special purpose devices, like conference phones, video phones, or appliances that contain other main functionalities besides the VoIP function
- Video gateways providing conditional access "termination", characterized by their capability to receive select and descramble multiple digital video streams to be rerouted on a home network or/and locally decoded to output audio video content. Video gateways equipped with embedded audio/ video decoding and outputting capability are commonly called "headed" video gateways.
- Enterprise CPE products, intended as those equipment that include one or both of the following characteristics and are typically intended to be used in high end applications and users:
    - o Works only with other dedicated proprietary controlling device/server.
    - o Is modular (i.e., allowing non-standardized, proprietary LAN, or WAN interfaces to be inserted in the equipment).

Table 2: Network equipment covered

Type of network equipment covered
• DSL network equipment (e.g., ADSL, ADSL2, ADSL2plus, VDSL2 and G.fast) • Combined DSL/Narrowband network equipment (e.g., MSAN where POTS interface is combined with DSL BroadBand interface) • Optical Line Terminations (OLT) for PON- and PtP-networks • Wireless Broadband network equipment (e.g., Wi-Fi access points for Hotspot application and Radio Access Network Equipment)

- Cable service provider equipment (e.g. CCAP, CMTS and Edge-QAM)

2. AIM

To reduce energy consumption of broadband communication equipment without hampering the fast technological developments and the service provided.

3. COMMITMENT

Signatories of this Code of Conduct agree to make all reasonable efforts to:

a) Abide by the General Principles contained in Annex A.

b) Achieve the power consumption targets set out in Annex C, for at least 90% (by number[2]) of the new-model of broadband equipment in each category (Section C.1.1 to C.1.4 and 0 to C.2.5) covered by this Code of Conduct that are introduced to the market after the indicated dates. For an equipment vendor, "new-model" means equipment that is first placed on the market[3] during a given year (note that a simple production optimisation or bug-fix would not necessarily constitute a new-model). For a network operator, "new-model" means equipment of a particular type and specification being procured for the first time in a given year. For the subsequent manufacture or purchase/installation of the same equipment, the Code of Conduct values pertaining to the original year of introduction/purchase apply. To take into account the time network operators need to select new equipment and introduce it into their networks, network operators are entitled to specify the Tier of the Code of Conduct that applied at the date on which the operator formally initiated the procurement process for this equipment (e.g. the date on which the Invitation to Tender for that equipment was issued). If this approach is employed, the operator shall formally notify the supplier of the relevant date and Tier.

c) Provide end-users with information about power consumption of CPE (CPE-on-state, CPE-idle-state) and about switching off CPE in the user manual, on the Internet, the packaging, and/or at the point of sales.

d) Co-operate with the European Commission and Member State authorities in an annual review of the scope of the Code of Conduct and the power consumption targets for future years.

e) Co-operate with the European Commission and Member States in monitoring the effectiveness of this Code of Conduct through the reporting form that is available on the homepage of the EU Standby Initiative [3].

f) Ensure that procurement specifications for broadband equipment are compliant with this Code of Conduct.

Each version of the Code of Conduct, once published, is a standalone document that supersedes all previous versions, and neither refers to nor depends on such versions. When a new version of the Code of Conduct comes into force, it is assumed that

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2 For CPE, 'by number' means 'by number of units placed on the market'. For network equipment 'by number' means 'by number of ports placed on the market', so as to allow for equipment with very different numbers of ports.

3 "A product is placed on the market when it is made available for the first time on the Union market." [31]

companies/organizations who have already signed the Code of Conduct will remain signatories for the new version. However any company/organization may withdraw its signature from the Code of Conduct with no penalty.

4. MONITORING

Signatories agree to provide information on the power consumption of their equipment which is covered by the Code of Conduct to the European Commission on annual basis. This should be provided by the end of each March for the previous calendar year. Where a signatory first signs part way through a calendar year, then reporting for that first year should be done from the date of signing, not the beginning of that calendar year.

The anonymous results will be discussed at least once a year by the signatories, the European Commission, Member States, and their representatives in order to:

a) Evaluate the level of compliance and the effectiveness of this Code of Conduct in achieving its aims.

b) Evaluate current and future developments that influence energy consumption, (i.e., Integrated Circuit development, etc.) with a view to agreeing actions and/or amendments to the Code of Conduct.

c) Set targets for future time periods.

5. REPORTING

The presentation of the results provided to the Commission will be in the form of the reporting sheet available on the homepage of the EU Standby Initiative [3].

A. GENERAL PRINCIPLES

Signatories of this Code of Conduct should endeavour to make all reasonable efforts to ensure that:

A.1 For broadband equipment in general

A.1.1 Broadband equipment should be designed to meet the Code of Conduct power consumption targets. However, power management must not unduly impact the user experience, disturb the network, or contravene the applicable standards.

A.1.2 Operational and control systems are specified under the assumption that hardware has power management built in, where applicable, i.e., depending on the functionality required of the unit, the hardware will automatically switch to the state with the lowest possible power consumption.

A.1.3 Signatories will endeavour to assist in the improvement of the existing low-power standards, and the development of new ones as appropriate.[4]

A.2 For CPE

A.2.1 Any external power supplies used for CPE shall be in accordance with the EU Code of Conduct for External Power Supplies [4]. Power consumption of the external power supply shall be included in the power measurement.

A.2.2 CPE shall be designed under the assumption that the equipment may be physically disconnected from the mains or switched off manually by the customer, from time to time, at their own discretion.

A.2.3 Power delivered to other external equipment (e.g., over USB, PoE or to a reversed powered G.fast DPU port) shall not be included in the power consumption assessment of a CPE. This other equipment shall be disconnected for the power consumption measurement, except when this is in contradiction with the operation of the product. However, target values are specified for some specific USB devices, as a reference for USB manufacturers, and to be considered separately from the evaluation of the power budget (and related consumption objectives) of the CPEs they can be connected to.

A.3 For network equipment

A.3.1 Broadband network equipment should be designed to fulfil the environmental specifications of Class 3.1 for indoor use according to the ETSI Standard EN 300019-1-3 [5], and where appropriate the more extended environmental conditions than Class 3.1 for use at outdoor sites. At remote sites the outdoor cabinet including the Broadband network equipment shall fulfil Class 4.1 according to the ETSI Standard EN 300019-1-4 [6]. Broadband network equipment in the outdoor cabinet should be designed taking in account the characteristics of the cabinet and the outdoor environmental condition; e.g., in case of free cooling cabinet it should be considered that the equipment inside the cabinet could operate (for short time

[4] For WAN-side DSL systems, this function can be activated (with care) for deployed ADSL2/2plus (see BBF TR-202 guidelines).

periods) at temperature up to 60° C. If cooling is necessary, it should be preferably cooled with fresh air (fan driven, no refrigeration). The Coefficient of Performance of new site cooling systems, defined as the ratio of the effective required cooling power to the energy needed for the cooling system, should be higher than 10.

B. DEFINITION OF OPERATION STATES

B.1 Definitions of CPE operation states

B.1.1 Off-state

In the **off-state**, the device is not providing any functionality. This state is defined by EC No 1275/2008 [9].

B.1.2 Idle-state

In the **idle-state**, the device is idle, with all the components being in their individual idle states. In this state the device is not processing or transmitting a significant amount of traffic, but is ready to detect activity.

Transitions between the idle-state and on-state must occur without manual reconfiguration of the device, i.e., they must happen automatically.

The definition of idle state for LAN Ethernet Ports of the Home Gateway in Table 3 is different from the definition of the idle state for LAN Ethernet Ports of simple broadband access devices (modems and NTs) in Table 4. For a Home Gateway, no LAN Ethernet port is connected for Idle-state testing. For a simple broadband access device (modems and NTs), one LAN Ethernet port is connected with link up, ready to pass traffic. The difference is due to the fact that the LAN Ethernet port of a modem is required to be operational at all times, while this is not necessarily the case for a Home Gateway.

The idle-state of a home gateway is defined as all the components of the home gateway being in their idle-state as defined in Table 3.

Table 3: Definition of the idle-state for home gateways

Port / component	Idle-state
Central functions (processor and memory: routing, firewall, OAM (e.g., TR-069), user interface)	Not processing user traffic.
WAN interface	Single WAN: Idle (link established and up, the interface is ready to transmit traffic but no user traffic is present. More details on the physical layer configuration of certain interfaces can be found in the on-state definitions (see Table 7). The idle state configuration can be different than in on-state if this does not require a manual reconfiguration by the end user (e.g., in case of DOCSIS 3.0, the CPE transitions to a 1x1 configuration, in case of ADSL2plus transition to the L2 mode, or in case of G.fast transition to the discontinuous operation

Port / component	Idle-state
	interval). In case of dual WAN interface[5], for backup or alternative purposes, only one of the two ports will be in the Idle-state described above for a Single WAN, while the second will be disconnected or not active, but able to be manually or automatically activated if needed. In case of dual WAN interface for simultaneous operation, both ports will be in the Idle-state described above for a Single WAN.
LAN Ethernet ports	Ports not connected (or no Ethernet link) but with Ethernet link detection active.
Wi-Fi	Beacon on, but no user traffic transmitted, no client associated.
Alternative LAN technologies (e.g. HPNA, MoCA, Powerline, POF)	MoCA, Powerline, HPNA, or POF capability is activated, but no user traffic transmitted.
FXS	1 FXS port with phone connected (200 Ohm / 5m max cable length), phone on-hook, off hook detection active. Remaining FXS ports: no phone or other load connected, but able to detect a connection.
ISDN S0	1 phone connected (5m max cable length), the phone is powered locally by its own power supply (i.e., it is not powered via the S0 interface), phone on-hook, off hook detection active. Remaining ISDN S0 ports: no phone or other load connected, but able to detect a connection.
FXO	No active call, incoming call detection enabled.
DECT interface	No active call, incoming call detection enabled.
DECT charging station for DECT handset	DECT handset on cradle, in trickle charge.
Backup battery	Battery is fully charged (trickle charging).
USB	No devices connected, detection of USB devices active.

When activity is detected on a component, the appropriate components transition to the on-state. The transition time should be less than 1 second wherever possible in order to not adversely impact the customer experience. The detection of the Ethernet link may take more than 1 second, but must stay below 3 seconds. This longer transition time can be tolerated in this case because it requires some user interaction to bring up the link (e.g., connect a device or boot a PC).

[5] It should be noted that CPEs may exist with more than two WAN interfaces (e.g. in case of DSL bonding over more than two copper pairs). In the remainder of this document dual WAN interface CPEs are mentioned as the most common category of multi-WAN CPEs.

Note that because only those components required to support the activated service go into their on-state, for a complete device (as opposed to a functional component) there will in fact be a range of power states. At any given time, the CPE should consume the minimum power commensurate with its current level of activity (with the appropriate hysteresis).

Table 4: Definition of the idle-state for simple broadband access devices (modems and NTs)

Port / component	Idle-state
WAN port	Idle (link established and up, the interface is ready to transmit traffic but no user traffic is present).
LAN port	In idle state the LAN port is up and a link is physically and logically established (cable length is 10m as defined in ETSI EN 301575). There is no user traffic transmission on the link only, some insignificant handshake traffic is allowed.

Table 5: Definition of the idle-state for Home Network Infrastructure Devices (HNID)

Port / component	Idle-state
Ethernet port	1 port in idle state (see LAN port in Table 4), in case of more than 1 port the remaining ports are disconnected but with Ethernet link detection active.

The definitions of the idle-state for all other interfaces and functionality are the same as defined in Table 3.

Table 6: Definition of the idle-state for other home network devices

Port / component	Idle-state
Ethernet port	1 port in idle state (see LAN port in Table 4), in case of more than 1 port the remaining ports are disconnected but with Ethernet link detection active.
VoIP/telephony	No active call, call detection active, inactive display.

B.1.3 On-state

The on-state of a home gateway is defined as all the components of the home gateway being in their on-state as defined in Table 7.

For the interfaces carrying user traffic the minimal throughput that needs to be considered is indicated as well in Table 7. As this is the minimal traffic load to be applied to a certain interface, some interfaces can carry more traffic in order to accommodate all minimal traffic loads. This excess traffic should be carried on Ethernet LAN port(s).

Customer-side Ethernet ports present on CPEs are responsible of non-negligible energy consumption. Energy Efficient Ethernet (EEE) as defined in IEEE Std 802.3-2012 SECTION SIX [11] defines power saving mechanisms for wired, customer-side Ethernet ports (see also Annex G). It is then required that copper Ethernet (IEEE 802.3 [11]) interfaces in the CPE comply with EEE and requires that such function be activated. , During testing, the measurement equipment connected to EEE capable ports must also support EEE [11].

Transitions between the idle-state and on-state must occur without manual reconfiguration of the device, i.e., they must happen automatically.

Table 7: Definition of the on-state for home gateways

Port / component	On-state
Central functions (processor and memory: routing, firewall, OAM (e.g., TR-069), user interface)	Processing the user traffic present on the WAN and LAN interfaces.
WAN port	Single WAN: Active (link established and passing user traffic) In case of dual WAN interface, for backup or alternative purposes, only one of the two ports will be in the On-state described above for a Single WAN, while the second will be disconnected or not active, but able to be manually or automatically activated in case of need. In case of dual WAN interface for simultaneous operation, both ports shall be in the On-state described above for a Single WAN.
ADSL2plus	Line is configured as per TR-100 [13], Table 8-3. Select a valid ADSL2plus specific test profile, configured in rate adaptive mode. Use a test loop of 1250m. The DSL line is active (in showtime) and passing user traffic: 1 Mbit/s downstream, 1 Mbit/s upstream.
VDSL2 (8, 12a, 17a, but not 30a)	Line is configured as per TR-114 [14], Table 9 (Specific Line Settings). Select a valid VDSL2 profile line combination, for the governing profile bandwidth (namely 8, 12, or 17 MHz), configured in rate adaptive mode. Use a test loop of 300 m for the 8 MHz profile and 150 m for each of the 12 and 17 MHz profiles. The DSL line is active (in showtime) and passing user traffic: 10 Mbit/s downstream, 10 Mbit/s upstream.
VDSL2 (30a)	Line is configured as per Broadband Forum Recommendation TR-114 [14], Table 9 (Specific Line Settings), VDSL2 Band Profile shall be: Profile 30a, using a valid Annex B PSD mask, configured in rate adaptive mode. Use a test loop of 100m. The DSL line is active (in showtime) and passing user traffic: 10 Mbit/s downstream, 10 Mbit/s upstream.
VDSL2 (35b)	Line is configured as per Broadband Forum Recommendation Amendment 2 to TR-114 Issue 3 [22]. VDSL2 Band Profile shall be: Profile 35b, using the Annex Q (998ADE35-M2x-M) PSD mask, configured in rate adaptive mode. Use a test loop of 100m. The DSL line is active (in showtime) and passing user traffic: 10 Mbit/s downstream, 10 Mbit/s upstream
G.fast	Line is configured as per the following settings:

Port / component	On-state
	• MF=36, Mds=28, Mus=7, Mf=36. • 106a MHz profile, operating in the 2MHz – 106MHz frequency band and with the FM broadcast band (88-106 MHz) notched • test loop of 50m. The line is active (in showtime) and passing user traffic: 10 Mbit/s downstream, 10 Mbit/s upstream.
Fast Ethernet WAN	Link established at 100 Mbit/s and passing user traffic: concurrent 1 Mbit/s downstream and 1 Mbit/s upstream sent in bursts of 25 back-to-back 500 bytes Ethernet Frames (CRC included). These rate, size and traffic shape are selected to ensure that the Ethernet Interface can activate EEE Low-Power Idle mode during testing (i.e., the interface will return to idle mode between each burst).
Gigabit Ethernet WAN	Link established at 1000 Mbit/s and passing user traffic: concurrent 10 Mbit/s downstream and 10 Mbit/s upstream sent in bursts of 250 back-to-back 500 bytes Ethernet Frames (CRC included). These rate, size and traffic shape are selected to ensure that the Ethernet Interface can activate EEE Low-Power Idle mode during testing (i.e., the interface will return to idle mode between each burst).
Fibre PtP Fast Ethernet WAN	Link established at 100 Mbit/s and passing user traffic: 10 Mbit/s downstream, 10 Mbit/s upstream.
Fibre PtP Gigabit Ethernet WAN	Link established at 1000 Mbit/s and passing user traffic:10 Mbit/s downstream, 10 Mbit/s upstream.
PON (all types such as GPON, EPON, XG-PON1, etc.)	Passing user traffic: 10 Mbit/s downstream, 10 Mbit/s upstream.
DOCSIS 2.0	Active with a downstream channel with a modulation type of 256 QAM and an upstream channel with a modulation type of 64 QAM and a symbol rate of 5,12 Ms/s and passing user traffic: 10 Mbit/s downstream, 2 Mbit/s upstream.
DOCSIS 3.0	4 downstream channels with a modulation type of 256 QAM. 4 upstream channels with a modulation type of 64 QAM, a symbol rate of 5,12 Ms/s, and a transmit level of 45 dBmV per channel. Modem is passing user traffic: 10 Mbit/s downstream, 10 Mbit/s upstream. The Basic configuration represents a modem that supports 4 downstream and 4 upstream channels. An additional power allowance is provided for each additional 4 downstream channels supported by the modem.
DOCSIS 3.1	For further study

Port / component	On-state
WiMAX, 3G, LTE	Passing user traffic: 1 Mbit/s downstream, 200 kbit/s upstream.
LAN Fast Ethernet ports	All ports active, link established at 100 Mbit/s, cable length is 10m as defined in ETSI EN 301575 and passing user traffic: concurrent 1 Mbit/s downstream and 1 Mbit/s upstream per port sent in bursts of 25 back-to-back 500 bytes Ethernet Frames (CRC included). These rate, size and traffic shape are selected to ensure that the Ethernet Interface can activate EEE Low-Power Idle mode during testing (i.e., the interface will return to idle mode between each burst).
LAN Gigabit Ethernet ports (1G through 10G)	All ports active, link established at 1000 Mbit/s, cable length is 10m as defined in ETSI EN 301575 and passing user traffic: concurrent 10 Mbit/s downstream and 10 Mbit/s upstream per port sent in bursts of 250 back-to-back 500 bytes Ethernet Frames (CRC included). These rate, size and traffic shape are selected to ensure that the Ethernet Interface can activate EEE Low-Power Idle mode during testing (i.e., the interface will return to idle mode between each burst).
Wi-Fi 802.11g or 11a	Beacon on, 1 Wi-Fi client associated and 1-5m away from AP in the same room, avoid interference in the same band, with user traffic: concurrent 1 Mbit/s downstream and 1 Mbit/s upstream.
Wi-Fi 802.11n or 11ac	Beacon on, 1 Wi-Fi client associated and 1-5m away from AP in the same room, avoid interference in the same band, with user traffic: concurrent 10 Mbit/s downstream and 10 Mbit/s upstream.
Alternative LAN technologies (e.g., HPNA, MoCA, Powerline, POF)	MoCA, Powerline, HPNA, or POF capability is activated, with user traffic: concurrent 10 Mbit/s downstream and 10 Mbit/s upstream per interface.
FXS	1 phone connected (200 Ohm / loop current of 20 mA / 5m max cable length), off hook, 1 active call. Remaining FXS ports: no phone or other load connected, but able to detect a connection (for those FXS ports, the idle targets apply).
ISDN S0	1 phone connected (5m max cable length), the phone is powered locally by its own power supply (i.e., it is not powered via the S0 interface), phone off hook, 1 active call. Remaining ISDN S0 ports: no phone or other load connected, but able to detect a connection (for those ISDN S0 ports, the idle targets apply).
FXO	1 active call.
DECT interface	1 active call.
DECT charging station for DECT handset	DECT handset not on cradle, no charging.
Backup battery	Battery is fully charged (trickle charging).

Port / component	On-state
USB	No USB device connected, detection of USB devices active.
Low speed power line	Active, with traffic: 10 kbit/s.
Bluetooth	Active, with traffic: 10 kbit/s.
Zigbee	Active, with traffic: 10 kbit/s.
Femtocell (Home use, RF power ≤10mW, RF power 10mW-50mW)	active, client 5m away in the same room, with user traffic: 2 Mbit/s.

Table 8: Definition of the on-state for simple broadband access devices (modems and NTs)

Port / component	On-state
WAN port	Active (link established and passing user traffic with the traffic load defined in Table 7 for a given WAN interface type).
LAN port	Active (link established and passing the same amount of user traffic as defined for the WAN port).

For the on-state of Home Network Infrastructure Devices (HNID) the same definitions as listed in Table 7 apply.

Table 9: Definition of the on-state for other home networking devices

Port / component	On-state
Ethernet port	Port active (user traffic transmission to support the functionality of the device as described in the rows below, cable length is 10m as defined in ETSI EN 301575).
VoIP/telephony	1 active call.
Print server	Print job active.

B.2 Definitions of network operation states

For Broadband-Network-technologies the following states are differentiated:

- Network (e.g., DSL)-stand-by state: This state has the largest power reduction capability and there is no transmission of data possible. It is essential for this state that the device has the capability to respond to an activation request, leading to a direct state change. E.g., a transition to the network-full-load state may happen if data has to be transmitted from either side.
- Network (e.g., DSL)-low-load state: This state allows a limited power reduction capability and a limited data transmission is allowed. It is entered automatically from the network-full-load state after the data transmission during a certain time is lower than a predefined limit. If more than the limited data has to be transmitted from either side, a state change to the network-full-load state is entered automatically. The network-low-load state may comprise multiple sub-states with history dependent state-transition rules.
- Network (e.g., DSL)-full-load state: This is the state in which a maximal allowed data transmission is possible. The maximum is defined by the physical properties of the line and the settings of the operator.
- For the wireless network equipment also the following states are defined:
    - Busy hour-load-state
    - Medium-load-state
    - Low-load-state

C. POWER LEVELS: TARGETS AND TIME SCHEDULE

C.1 CPE

CPEs covered by this Code of Conduct (home gateways, home network infrastructure devices and other home network devices) should meet the following maximum power consumption targets in the on-state and in the idle-state as defined in section B.1. In the off-state, these CPEs must meet the requirements of the Code of Conduct for External Power Supplies [4].

The CPEs should apply all possible energy saving actions, minimizing the overall power consumption whenever possible (e.g., when all or some of its functions are not operating).

The power levels defined in this document for all states are mean values based on sufficiently long measurement periods (at least 5 minutes), during which the equipment remains continuously in that same state (measurements should only start when the equipment is stable in this state for at least 60 seconds). Power is measured at the 230V AC input.

C.1.1 Home Gateways

The home gateway[6] is composed of several components, namely a processor plus memory, a WAN interface and several LAN interfaces. Depending on the purpose of a given home gateway, different components may be included. The power consumption targets for each type of home gateway are calculated by summing the values of its individual components. The home gateway as a whole has to meet the summed targets for its various modes of operation and activity. Component power consumption values are used to compute the overall home gateway target for a given configuration and mode of operation, but are not themselves normative.

The home gateway must meet the power targets for idle-state and for on-state as defined in section B.1. Depending on the actual state of the individual components, several intermediate power consumption levels for the home gateway exist.

The values per component for the idle-state and the on-state are given in the following tables.

If an interface is able to work in different modes it must establish a link with the highest possible capability and the targets have to be chosen accordingly. This for example applies to VDSL2, Wi-Fi 802.11n interfaces or Gigabit Ethernet LAN ports. I.e., for a Gigabit Ethernet interface, a Gigabit Ethernet capable device must be connected for measurement purposes and the Gigabit Ethernet target applies. The targets are defined taking into account that certain interfaces may have this capability of falling back from a higher capability to a lower one. If a lower capability device is connected, the power consumption should be lower and ideally reach the target of this lower capability technology, i.e., if a Fast Ethernet device is connected to a Gigabit Ethernet LAN port. Measurements in such lower capability configuration are not to be reported.

In cases where an interface is a removable module (e.g. Small Form-factor Pluggable (SFP) devices), vendors providing a CPE but no removable module must test the CPE without the module and report results, while vendors providing a CPE with removable modules and operators must test with the removable module present and with the allowances associated with it. If different types of modules are to be used by a single product, each type must meet

[6] A home gateway is used here as a generic term which encompasses all kinds of access interfaces (e.g. DSL, cable, fibre, etc.)

the allocated budget but only the highest measurement is to be reported. Additional rules described below also apply in the case where the module is used in dual or backup WAN configurations.

In case of dual WAN, with reference to the definition of states, the calculation of targets for idle and on state will be performed on the basis of the following rules:

In case of dual WAN interface for backup or alternative purposes, the backup or alternative interface will be activated when the main interface loses connectivity. Additional allowances for the backup interfaces are found in Table 10a. Although only one WAN interface is active at any time, the calculation of the total budget must not take into account which interface is idle and which is active during testing and must be calculated only once. This total budget must be met under the below two conditions (and only the highest value for the Idle-State and the highest value for the On-state must be reported):

- The first one, corresponding to the situation when the main WAN interface is active and the backup or alternative interface is disconnected or not active
- The second one, corresponding to the situation when the backup is activated and the main interface is disconnected or not active

In case of dual WAN interface for simultaneous operation, additional allowances for the additional interfaces are found in Table 10b. The targets must be met under a test condition where both WAN interfaces are simultaneously connected and active in On mode.

Table 10: Power values for home gateway central functions plus WAN interface

Home gateway central functions plus WAN interface	**Tier 2017:** 1.1.2017 - 31.12.2017		**Tier 2018:** 1.1.2018 - 31.12.2018	
	Idle-State (W)	***On-State (W)***	***Idle-State (W)***	***On-State (W)***
ADSL2plus	2,2	2,8	2,0	2,4
VDSL2 (8, 12a, 17a, but not 30a) | Note 10.3	3,2	4,0	3,0	3,7
VDSL2 (30a) | Note 10.3	4,3	4,8	3,6	4,1
VDSL2 (35b) | Note 10.3	3,8	4,4	3,8	4,4
G.fast	3,5	4,1	3,2	3,9
Fast Ethernet WAN	1,5	2,0	1,4	1,7
Gigabit Ethernet WAN	2,5	4,5	2,3	3,7
2.5 Gigabit Ethernet WAN	3,0	5,0	3,0	5,0
5 Gigabit Ethernet WAN	3,0	5,0	3,0	5,0
10-Gigabit Ethernet WAN	4,0	6,5	4,0	6,5
Fibre PtP Fast Ethernet WAN	2,5	4,5	2,1	3,9
Fibre PtP Gigabit Ethernet WAN	2,6	4,8	2,1	4,1
GPON	3,2	4,0	3,0	3,3

Home gateway central functions plus WAN interface	**Tier 2017:** 1.1.2017 - 31.12.2017		**Tier 2018:** 1.1.2018 - 31.12.2018	
	Idle-State (W)	***On-State (W)***	***Idle-State (W)***	***On-State (W)***
1G-EPON	3,2	4,0	3,0	3,3
10/1G-EPON	Note 10.4 | 4,0	Note 10.4 | 5,0	3,2	4,2
10/10G-EPON	Note 10.4 | 4,5	Note 10.4 | 6,3	3,5	5,5
10/2.5 XG-PON1 or NG-PON2	Note 10.4 | 4,0	Note 10.4 | 5,2	3,2	4,6
10/10 XGS-PON or NG-PON2	3,5	6,0	3,5	6,0
DOCSIS 2.0	3,7	4,6	3,6	4,4
DOCSIS 3.0 basic configuration	5,2	6,2	5,2	5,7
DOCSIS 3.0 additional power allowance for each additional 4 downstream channels	2,0	2,5	1,3	2,0
WiMAX	2,8	4,8	2,8	4,0
3G	2,8	4,8	2,8	4,0
LTE	2,8	4,8	2,8	4,0

Notes:

(10.1) The ONU values shown in Table 10 assume that the home gateway central functions include a Gigabit Ethernet switch functionality (the additional power budget for the PHY interface of the LAN ports will have to be accounted separately).

(10.2) The above consumption targets for all ONUs in Table 10 assume the use of optics that meet the PR-30 or PRX-30 power budgets (IEEE 802.3) or ITU-T G.984.2/G.987.2 [15] Class B/B+ power budgets, whichever is applicable.

(10.3) VDSL2 allowances include Home Gateways supporting G.993.5 (Vectoring).

(10.4) The state of maturity of this technology is such that only indicative power targets can be set. Signatories must report the power consumptions values of any such equipment that they manufacture or deploy, so that the state of development of this technology can be taken into account when revising these targets in the future. Such reports will not be included in the assessment of whether or not the 90% target has been achieved.

Table 10a: Power values for home gateway additional Backup WAN interface

Home gateway additional Backup WAN interface	**Tier 2017:** 1.1.2017 - 31.12.2017		**Tier 2018:** 1.1.2018 - 31.12.2018	
	Idle-State (W)	***On-State (W)***	***Idle-State (W)***	***On-State (W)***
ADSL2plus	0,3	1,0	0,3	1,0
VDSL2 (8, 12a, 17a, but not 30a) | Note 10.3	0,4	1,5	0,4	1,5
VDSL2 (30a) | Note 10.3	0,5	1,5	0,5	1,5
VDSL2(35b) | Note 10.3	0,4	1,5	0,4	1,5
Fast Ethernet WAN	0,2	0,4	0,2	0,3
Gigabit Ethernet WAN	0,3	1,0	0,3	0,8
2.5 Gigabit Ethernet WAN	0,4	0,8	0,4	0,8
5 Gigabit Ethernet WAN	0,4	0,8	0,4	0,8
10-Gigabit Ethernet WAN	1,1	2,0	1,1	2,0
Fibre PtP Fast Ethernet WAN	1,1	2,4	1,2	2,3
Fibre PtP Gigabit Ethernet WAN	1,4	3,0	1,4	3,0
WiMAX	1,7	3,4	1,7	3,0
3G	1,7	3,4	1,7	3,0
LTE	1,7	3,4	1,2	3,0

Table 10b: Power values for home gateway additional Simultaneous WAN interface

Home gateway additional Simultaneous WAN interface	**Tier 2017:** 1.1.2017 - 31.12.2017		**Tier 2018:** 1.1.2018 - 31.12.2018	
	Idle-State (W)	***On-State (W)***	***Idle-State (W)***	***On-State (W)***
ADSL2plus | Note 10.3	0,9	1,0	0,9	1,0
VDSL2 (8, 12a, 17a, but not 30a) | Note 10.3	1,6	2,0	1,6	1,7
VDSL2 (30a) | Note 10.3	2,5	2,9	2,1	2,3
VDSL2 (35b) | Note 10.3	2,3	2,6	2,3	2,6
G.fast	2,0	2,3	1,8	2,3
Fast Ethernet WAN	0,4	0,6	0,4	0,6
Gigabit Ethernet WAN	0,6	1,0	0,6	0,8
2.5 Gigabit Ethernet WAN	0,8	0,8	0,8	0,8
5 Gigabit Ethernet WAN	0,8	0,8	0,8	0,8
10 Gigabit Ethernet WAN	1,5	2,0	1,5	2,0
Fibre PtP Fast Ethernet WAN	1,3	2,6	1,2	2,3
Fibre PtP Gigabit Ethernet WAN	1,6	3,2	1,4	2,8
WiMAX	1,9	3,6	1,9	3,4
3G	1,9	3,6	1,9	3,4
LTE	1,9	3,6	1,9	3,4

Table 11: Power values for home gateway LAN interfaces and additional functionality

Home gateway LAN interfaces and additional functionality	Tier 2017: 1.1.2017 - 31.12.2017		Tier 2018: 1.1.2018 - 31.12.2018	
	Idle-State (W)	*On-State (W)*	*Idle-State (W)*	*On-State (W)*
1 Fast Ethernet port	0,2	0,3	0,2	0,3
1 Gigabit Ethernet port	0,2	0,4	0,2	0,4
2.5 Gigabit Ethernet	0,7	2,5	0,7	2,5
5 Gigabit Ethernet	0,7	2,5	0,7	2,5
10 Gigabit Ethernet	1,5	3,5	1,5	3,5
Network Processor	0,3	0,5	0,3	0,5
Wi-Fi interface, IEEE 802.11g with up to 20 dBm EIRP or 11a/h radio with up to 23 dBm EIRP | Note 11.1	0,7	1,3	0,7	1,2
Wi-Fi interface, IEEE 802.11a/h radio with up to 30 dBm EIRP | Note 11.1	0,7	2,2	0,7	1,9
Wi-Fi interface, IEEE 802.11n radio at 2,4 GHz with up to 20 dBm total EIRP (up to 2x2) or at 5,0 GHz with up to 23 dBm total EIRP (up to 2x2) | Note 11.1	0,8	2,0	0,8	1,8
Wi-Fi interface, IEEE 802.11n radio at 5 GHz with up to 30 dBm total EIRP (up to 2x2) | Note 11.1	0,8	2,5	0,8	2,0
Wi-Fi, IEEE 802.11ac 2x2 radio at 2,4 GHz with up to 17 dBm EIRP per chain (20 dBm EIRP total for 2x2) | Note 11.1	1,0	2,5	1,0	2,0
Wi-Fi, IEEE 802.11ac 2x2 radio at 5 GHz with up to 20 dBm EIRP per chain (23 dBm EIRP total for 2x2) | Note 11.1	2,1	3,4	1,6	2,1
Wi-Fi, IEEE 802.11ac 2x2 radio at 5 GHz with up to 27 dBm EIRP per chain (30 dBm EIRP total for 2x2) | Note 11.1	2,1	3,8	1,8	2,5
Additional allowance per 802.11n RF chain above a 2x2 MIMO configuration (e.g., for 3x3 and 4x4) with up to 20 dBm EIRP per chain	0,1	0,3	0,1	0,3
Additional allowance per 802.11n RF chain above a 2x2 MIMO configuration (e.g., for 3x3 and 4x4) with up to 27 dBm EIRP per chain	0,1	1,5	0,1	0,4
Additional allowance per 802.11ac RF chain above a 2x2 MIMO configuration (e.g., for 3x3 and 4x4) with up to 20 dBm EIRP per chain	0,3	0,6	0,3	0,6
Additional allowance per 802.11ac RF chain above a 2x2 MIMO configuration (e.g., for 3x3 and 4x4) with up to 27 dBm EIRP per chain	0,3	0,9	0,3	0,9

Home gateway LAN interfaces and additional functionality	**Tier 2017:** 1.1.2017 - 31.12.2017		**Tier 2018:** 1.1.2018 - 31.12.2018	
	Idle-State (W)	***On-State (W)***	***Idle-State (W)***	***On-State (W)***
HPNA	1,5	2,0	1,5	2,0
POF (up to 200 Mbit/s)	0,4	0,4	0,4	0,4
POF (above 200 Mbit/s)	1,8	1,8	1,5	1,6
MoCA 1.1	1,7	2,1	1,5	2,0
MoCA 2.0	1,7	2,1	1,5	2,0
Powerline - High speed for broadband home networking (up to 30MHz bandwidth)	1,3	1,8	1,2	1,6
Powerline - High speed for broadband home networking (up to 68 MHz bandwidth)	2,0	2,7	1,5	2,4
Powerline - High speed for broadband home networking (up to 86 MHz bandwidth)	4,0	4,5	3,5	4,0
High speed Powerline adapters (2xN up to 86 MHz bandwidth)	4,7	5,5	4,0	5,0
Powerline - Low speed for smart metering and appliances control (Green Phy)	0,6	1,3	0,5	1,2
FXS (First interface)	0,2	1,0	0,2	0,9
FXS (Additional interface)	0,2	0,2	0,2	0,2
ISDN S0	0,2	0,3	0,2	0,3
FXO	0,2	0,7	0,2	0,6
Emergency fall-back to analog telephone per FXS	0,2	0,2	0,1	0,2
DECT GAP	0,5	0,9	0,5	0,9
DECT Cat-iq	0,5	1,0	0,5	0,9
DECT ULE	0,1	0,2	0,1	0,2
DECT charging station for DECT handset in slow/trickle charge	0,4	n.a.	0,4	n.a.
USB 2.0 | Note 11.3	0,1	0,1	0,1	0,1
USB 3.0 | Note 11.3	0,1	0,1	0,1	0,1
USB 3.1 | Note 11.3	0,1	0,1	0,1	0,1
SATA – no load connected	0,2	0,2	0,2	0,2
HDMI	0,2	0,2	0,2	0,2
Built-in back-up battery	0,1	0,1	0,1	0,1
Bluetooth	0,1	0,2	0,1	0,2
ZigBee	0,1	0,1	0,1	0,1

<table>
<tr><th rowspan="2">Home gateway LAN interfaces and additional functionality</th><th colspan="2">Tier 2017:
1.1.2017 - 31.12.2017</th><th colspan="2">Tier 2018:
1.1.2018 - 31.12.2018</th></tr>
<tr><th>Idle-State (W)</th><th>On-State (W)</th><th>Idle-State (W)</th><th>On-State (W)</th></tr>
<tr><td>Z-Wave</td><td>0,1</td><td>0,1</td><td>0,1</td><td>0,1</td></tr>
<tr><td>IEC 14543-310 (“EnOcean”)</td><td>0,1</td><td>0,1</td><td>0,1</td><td>0,1</td></tr>
<tr><td>Near Field Communication (NFC)</td><td>0,2</td><td>0,2</td><td>0,2</td><td>0,2</td></tr>
<tr><td>Femtocell (Home use, RF power ≤10mW)</td><td>4,5</td><td>5,5</td><td>4,0</td><td>5,0</td></tr>
<tr><td>Femtocell (Home use. RF power 10mW-50mW)</td><td>6,5</td><td>7,5</td><td>5,0</td><td>6,5</td></tr>
<tr><td>Integrated Storage (Flash e.g. eMMC, SSD or SD Card)</td><td>0,1</td><td>0,1</td><td>0,1</td><td>0,1</td></tr>
<tr><td>PCIe (Connected) | Note 11.2</td><td>0,2</td><td>0,2</td><td>0,2</td><td>0,2</td></tr>
<tr><td>PCIe for each additional lane (e.g. x2)</td><td>0,1</td><td>0,1</td><td>0,1</td><td>0,1</td></tr>
<tr><td>RF modulator (TV overlay for fibre network)</td><td>3,0</td><td>3,0</td><td>2,5</td><td>3,0</td></tr>
<tr><td>Embedded hands-free system</td><td>0,3</td><td>0,5</td><td>0,3</td><td>0,5</td></tr>
<tr><td>Additional Colour Display with Display size defined by area A in (dm2); (typically found in VoIP devices)</td><td colspan="4"></td></tr>
<tr><td>A ≤ 0,10</td><td rowspan="9">0,5</td><td>0,5</td><td rowspan="9">0,5</td><td>0,5</td></tr>
<tr><td>0,10 < A ≤ 0,30</td><td>0,9</td><td>0,8</td></tr>
<tr><td>0,30 < A ≤ 0,50</td><td>1,3</td><td>1,1</td></tr>
<tr><td>0,50 < A ≤ 0,70</td><td>1,7</td><td>1,4</td></tr>
<tr><td>0,70 < A ≤ 1,00</td><td>2,1</td><td>1,7</td></tr>
<tr><td>1,00 < A ≤ 1,40</td><td>2,5</td><td>2,0</td></tr>
<tr><td>1,40 < A ≤ 1,80</td><td>2,8</td><td>2,2</td></tr>
<tr><td>1,80 < A ≤ 2,20</td><td>3,1</td><td>2,4</td></tr>
<tr><td>2,20 < A ≤ 2,80</td><td>3,6</td><td>2,8</td></tr>
</table>

Notes:

(11.1) For simultaneous dual-band operation the allowances for the individual radios can be summed up.

(11.2) PCIe allowance is for an internal bus with 2 interfaces.

(11.3) The indicated allowance is either for an unconnected externally accessible USB interface, or for an internally connected USB interface. Also see section C.1.2.

There are types of home gateway device (e.g., a USB attached DSL modem or pure Layer 2 ONUs) that are so simple (e.g., only provide Layer 2 functionalities, does not contain an Ethernet switch, and has a single LAN interface) that it cannot be usefully decomposed into components. The power targets for such devices are given in Table 12.

Table 12: Power targets for simple broadband access devices (modems and NTs)

Modem and NT total power target for simple broadband access devices	**Tier 2017:** 1.1.2017 - 31.12.2017		**Tier 2018:** 1.1.2018 - 31.12.2018	
	CPE-Idle-State (W)	***CPE-On-State (W)***	***CPE-Idle-State (W)***	***CPE-On-State (W)***
GPON ONU with 1 Gigabit Ethernet LAN port	2,3	3,2	2,1	2,5
1G-EPON ONU with 1 Gigabit Ethernet LAN port	2,3	3,2	2,1	2,5
10/1G-EPON ONU with 1 Gigabit Ethernet LAN port	Note 12.4 | 3,6	Note 12.4 | 5,0	3,4	4,2
10/10G-EPON ONU with 1 Gigabit Ethernet LAN port	Note 12.4 | 4,1	Note 12.4 | 6,2	3,8	5,5
XG-PON1 ONU with 1 Gigabit Ethernet LAN port	Note 12.4 | 3,6	Note 12.4 | 5,4	3,4	4,7
Fast Ethernet PtPONU with 1 Fast Ethernet LAN port	2,6	2,6	2,3	2,5
Gigabit Ethernet PtP ONU with 1 Gigabit Ethernet LAN port	3,0	3,0	2,5	2,8

Notes:

(12.1) USB Modem Power consumption (W) is defined at the 5V USB Interface.

(12.2) The above consumption targets for all ONUs in Table 12 assume the use of optics that meet the PR-30 or PRX-30 power budgets (IEEE 802.3) or ITU-T G.984.2/G.987.2 Class B+ power budgets, whichever is applicable.

(12.3) If the ONU has a Fast Ethernet LAN port instead of a Gigabit Ethernet port the power targets are reduced by the difference between a Fast Ethernet LAN and a Gigabit Ethernet LAN port from Table 11.

(12.4) The state of maturity of this technology is such that only indicative power targets can be set. Signatories must report the power consumptions values of any such equipment that they manufacture or deploy, so that the state of development of this technology can be taken into account when revising these targets in the future. Such reports will not be included in the assessment of whether or not the 90% target has been achieved.

C.1.2 USB dongles

For a home gateway with USB ports additional functionality originally not built into the device can also be provided via USB dongles. The power consumption of USB dongles is measured at the DC 5V USB interface.

For a home gateway with an internal USB device, the power budget shall include the value of the USB device defined in table 13 multiplied by a factor of (1/0.84) plus the USB value for the interface defined in table 11 (also see note 11.3).

Please note that the USB devices are considered as not equipped with additional chipsets implementing applications or complex software stacks that will drastically change the power values.

Table 13: Power values for USB dongles

USB powered peripherals and dongles	**Tier 2017:** 1.1.2017 - 31.12.2017		**Tier 2018:** 1.1.2018 - 31.12.2018	
	Idle-State (W)	***On-State (W)***	***Idle-State (W)***	***On-State (W)***
3G/4G	0,4	1,5	0,4	1,5
DECT	0,3	0,5	0,2	0,4
DECT GAP	0,3	1,1	0,2	1,0
DECT Cat-iq	0,3	0,5	0,2	0,4
DECT ULE	0,1	0,3	0,1	0,2
Wi-Fi interface single IEEE 802.11b/g or 1x1 IEEE 802.11n radio | Note 13.1	0,6	1,7	0,5	1,5
Bluetooth	0,1	0,3	0,1	0,2
ZigBee	0,1	0,3	0,1	0,2
Z-Wave	0,1	0,3	0,1	0,2
IEC 14543-310 (“EnOcean”)	0,1	0,3	0,1	0,2

Notes:

(13.1) For Wi-Fi USB dongles with more than 1 RF chain, an allowance for additional RF chains as defined in Table 11 can be added.

C.1.3 Home Network Infrastructure Devices

Table 14: Power targets for Home Network Infrastructure Devices (HNID)

Power targets for Home Network Infrastructure Devices	**Tier 2017:** 1.1.2017 - 31.12.2017		**Tier 2018:** 1.1.2018 - 31.12.2018	
	Idle-State (W)	***On-State (W)***	***Idle-State (W)***	***On-State (W)***
Wi-Fi Access Points with IEEE 802.11b/g or 11a 2x2 radio	2,0	3,0	1,9	2,4
Wi-Fi Access Points with IEEE 802.11n or 802.11ac 2x2 radio with up to 20 dBm total EIRP at 2,4 GHz	2,1	3,3	1,9	2,7
Wi-Fi Access Points with IEEE 802.11n or 802.11ac 2x2 radio with up to 23 dBm total EIRP at 5 GHz	3,6	5,3	3,4	4,3
Wi-Fi Access Points with IEEE 802.11n or 802.11ac 2x2 radio with up to 30 dBm total EIRP at 5 GHz	3,6	5,7	3,4	5,0
Gigabit Ethernet optical LAN adapters (fiber converter or POF adapter)	2,8	2,8	2,5	2,5
Ethernet optical LAN adapters (fiber converter or POF adapter) up to 200 Mbit/s	1,3	1,3	1,2	1,2
MoCA LAN adapters	3,5	3,5	3,0	3,0
DECT ULE LAN adapters	0,2	0,2	0,2	0,2
ZigBee LAN adapters	0,2	0,3	0,2	0,2
Z-Wave LAN adapters	0,3	0,3	0,2	0,2
IEC 14543-310 (“EnOcean”) LAN adapters	0,2	0,3	0,2	0,2
High speed Powerline adapters (up to 30 MHz bandwidth)	2,5	3,5	2,3	3,0
High speed Powerline adapters (up to 68 MHz bandwidth)	3,5	4,0	2,5	3,5
High speed Powerline adapters (up to 86 MHz bandwidth)	4,3	4,5	3,8	4,0
High speed Powerline adapters (2xN up to 86 MHz bandwidth)	5,0	5,5	4,5	5,0
Powerline – low speed for smart metering and appliance control (Green Phy)	2,0	3,0	2,0	3,0
HPNA LAN adapter	3,2	3,6	3,2	3,6
Small hubs and non-managed 4 port Layer 2Fast Ethernet switches without CPU (no VPN	1,3	1,8	1,3	1,8

Power targets for Home Network Infrastructure Devices	**Tier 2017:** 1.1.2017 - 31.12.2017		**Tier 2018:** 1.1.2018 - 31.12.2018	
	Idle-State (W)	***On-State (W)***	***Idle-State (W)***	***On-State (W)***
or VoIP)				
Small hubs and non-managed 4 port Layer 2 Gigabit Ethernet switches without CPU (no VPN or VoIP)	1,4	2,5	1,4	2,5

An HNID is typically a relatively simple device, where 1 Ethernet LAN port is already considered to be part of the initial configuration. Ethernet switches with 4 ports are considered to be part of the initial configuration. If an HNID has more than 4 Ethernet ports, additional allowances for those Ethernet ports can be added as defined in Table 11.

For more complex HNIDs, the same allowances for additional functionality apply as for home gateways (see Table 11). A function used for control or monitoring such as smart plugs, smart sensor and remote controllable light devices are considered equivalent to an HNID.

C.1.4 Other Home Network Devices

Table 15: Power targets for other home network devices

Power targets for Home Network Devices	**Tier 2017:** 1.1.2017 - 31.12.2017		**Tier 2018-2018:** 1.1.2018 - 31.12.2018	
	Idle-State (W)	***On-State (W)***	***Idle-State (W)***	***On-State (W)***
ATA / VoIP gateway	1,3	2,1	1,3	1,9
VoIP telephone	2,7	3,5	2,4	3,2
VoIP telephone including Gigabit Ethernet Switching Function	3,9	4,3	3,6	3,9

Some types of other home network devices require additional functionality; in that case the same allowances for additional functionality apply as for home gateways (see Table 11).

C.2 Network equipment

The following targets are power consumption targets per port.

a) All power values of the DSL network equipment in line with point 0 (except G.fast), C.2.2 and C.2.3 are measured at the power interface port interface as described in the standard ETSI EN 303 215 [16] or at the AC input, in case of directly mains powered systems. For directly mains powered systems, the power limits stated in Table 16 through Table 26 (except Table 16b, Table 17a and Table 18) are increased by 10%. In case of integrated remote or reverse powered systems, the power limits stated are increased by 15% for remote and 30% for reverse powered systems.

b) Power measurements of the G.fast equipment shall be performed on fully equipped, maximum configured DPUs (100% of activated ports). The power consumption numbers specified in Table 16b, Table 17a and Table 18 assume no extra allowance for <=128 lines and no extra allowance for vectoring. Depending on the different types of powering, the power limits specified in Table 16b, Table 17a and Table 18 should be increased by additional allowances defined in Table 16c.

c) For multi-profile boards, the power consumption limits do not apply to boards profile not optimized under energy efficiency point of view. Equipment makers 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., 12a, 17a, 30a) but might have suboptimal performance at such additional profiles in terms of power consumption.

d) For boards which have additional functions (e.g., channel bonding) in addition to the bare DSL functionality, such boards are to be used in normal DSL mode of operation with any additional functions disabled. Optionally, a measurement with these functions enabled can be described/requested. If such additional functions cannot be fully disabled, manufacturers will declare what the extra power budget due to the added functionality is. Such an extra budget will not be considered in the per port power consumption computation.

e) In Table 16a, “vectored VDSL2” refers to a DSLAM that supports vectoring per ITU-T G.993.5 on all its lines and operates with one or multiple vectored groups. Each line is included in one vectored group. The term “vectored group” is defined in ITU-T G.993.5. The DSLAM is configured for VDSL2 operation according to ETSI EN 303 215 [16] with upstream and downstream vectoring enabled on all its lines. For the configured profile, the DSLAM operates on all its lines at its maximum supported transmit power and over the widest frequency bands over which it supports vectoring. The DSLAM operates at its maximum cancellation capabilities in terms of number of cancelled disturbers and of SNR improvement gained with cancellation.

C.2.1 Broadband DSL and G.fast network equipment

Table 16: DSL Broadband ports – full-load state (with service traffic on the lines as specified in Table 7)

Power targets for DSL-full-load-state	Tier 2017 (1.1.2017-31.12.2017) (W)	Tier 2018 (1.1.2018-31.12.2018) (W)
VDSL2 (profile 8b) transmission power 19,8 dBm	1,4	1,3
VDSL2 (profile 12a and 17a) transmission power 14,5 dBm	1,3	1,2
VDSL2 (profile 30a) transmission power 14,5 dBm	1,5	1,4
VDSL2 (profile 35b) transmission power 14,5 dBm	1,6	1,4
VDSL2 (profile 35b) transmission power 17 dBm	1,8	1,6
VDSL2 (profile 35b) based on G.fast capable transceiver 14,5 dBm	2,5	2,3
VDSL2 (profile 35b) based on G.fast capable transceiver 17 dBm	2,7	2,5

Table 16a: DSL Broadband ports – full-load state for Vectoring capable VDSL2 equipment

Equipment	Tier 2017 (1.1.2017-31.12.2017) (W)	Tier 2018 (1.1.2018-31.12.2018) (W)
Vectored VDSL2 (profile 12a and 17a with transmission power 14,5 dBm) without crosstalk cancelling among boards	+0,05	+0,05
Vectored VDSL2 (profile 12a and 17a with transmission power 14,5 dBm) with crosstalk cancelling among boards for up to 128 ports	+0,2	+0,15
Vectored VDSL2 (profile 12a and 17a with transmission power 14,5 dBm) with crosstalk cancelling among boards for more than 128 ports	+0,5	+0,4
Vectored VDSL2 (profile 30a with transmission power 14,5 dBm) without crosstalk cancelling among boards	+0,1	+0,08
Vectored VDSL2 (profile 30a with transmission power 14,5 dBm) with crosstalk cancelling among boards for up to 128 ports	+0,25	+0,2
Vectored VDSL2 (profile 30a with transmission power 14,5 dBm) with crosstalk cancelling among boards for more than 128 ports	+0,5	+0,4
Vectored VDSL2 (profile 35b with transmission power 14,5 dBm or 17dBm) without crosstalk cancelling among boards	+0,1	+0,1
Vectored VDSL2 (profile 35b with transmission power 14,5 dBm or 17dBm) with crosstalk cancelling among boards for up to 128 ports.	+0,2	+0,2
Vectored VDSL2 (profile 35b with transmission power 14,5 dBm or 17dBm) with crosstalk cancelling among boards for more than 128 ports.	+0,4	+0,4

Notes:

(16.1) Consumption limits are expressed as an additional allowance in [W/port] to be applied to the corresponding consumption target for non-vectoring capable VDSL2 equipment (see Table 16).

The above values apply to fully equipped, maximum configuration DSLAMs with more than 128 ports. For equipment up to 128 ports (and with maximum configuration) 0.15 W per line may be added to the above values, with a minimum value of 5 W for the whole DSLAM.

Table 16b: G.fast broadband ports – full-load-state (with service traffic on the lines as specified in Table 7)

Power targets for G.fast full-load-state	Tier 2017 (1.1.2017-31.12.2017) (W)	Tier 2018 (1.1.2018-31.12.2018) (W)
Profile 106a		
G.fast single line DPU	4,9	4,9
G.fast small multiline DPU, 2-16 lines	4,2	4,2
G.fast large multiline DPU, 17-48 lines	3,5	3,5
G.fast very large multiline DPU, 49-128 lines	3,0	3,0
Profile 106b		
G.fast single line DPU	5,2[i]	5,2[i]
G.fast small multiline DPU, 2-16 lines	4,5[i]	4,5[i]
G.fast large multiline DPU, 17-48 lines	3,8[i]	3,8[i]
G.fast very large multiline DPU, 49-128 lines	3,3[i]	3,3[i]
Note: Values marked [i] provide an indication for the power consumption.		

The above values in Table 16b apply to fully equipped, maximum configuration DPUs within each category (single line, small, large or very large multiline). These numbers assume no extra allowance for <=128 lines and no extra allowance for vectoring.

Table 16c: Allowances for different types of powering of DPU

Power type	Tier 2017 (1.1.2017-31.12.2017)	Tier 2018 (1.1.2018-31.12.2018)
Local Power from AC mains source	10%	10%
Forward Power from a Network Node	15%	15%
Reverse Power from the CPE	30%	30%

Table 17: Broadband ports – DSL-low-power-state

Power targets for DSL-low-power-state	Tier 2017 (1.1.2017-31.12.2017) (W)	Tier 2018 (1.1.2018-31.12.2018) (W)
VDSL2 L2.1 low power state (transport of VoIP (POTS level) and keep alive data) compared to full-load-state target per Table 16 and 16a	-25%[i]	-25%[i]
VDSL2 L2.2 low power state (transport of "keep alive" data at times when there is no user activity) compared to full-load-state target per Table 16 and 16a	-50%[i]	-50%[i]
Note: Values marked [i] provide an indication for the power consumption.		

Notes:

(17.1) The DSL-low-power-state should allow transport of VoIP (POTS data) and keep-alive data at different levels of power saving and quality of service VDSL2 low power mode (LPMode) is defined in Annex E of ITU-T G.998.4 [21] as the optional operation functionality. Therefore, Table 17 is applicable only to VDSL2 systems that support low power state. CO-MIB configuration parameters related to LPMode are defined in Table E.1 [21].

(17.2) Vectored VDSL2 targets are for further study.

Table 17a: Broadband ports – G.fast low-power-state

Power targets for G.fast low-power-state	Tier 2017 (1.1.2017-31.12.2017) (W)	Tier 2018 (1.1.2018-31.12.2018) (W)
L2.1 low power with mains powering (L2.1N)	N/A	N/A
L2.1 low power with battery powering (L2.1B)	N/A	N/A
L2.2 low power state (L2.2)	N/A	N/A

(17.3) L2.1 low power state (with two sub-states: L2.1N and L2.1B) allows substantial reduction in power consumption and is primarily intended for support of VoIP, while other services are unused. L2.2 low power state is intended for keep-alive applications during multi-hour battery backup and it implements significant reduction of power consumption (resulting in extremely reduced data rate and loss of QoS).

Table 18: Broadband ports – DSL and G.fast standby-state

Power targets for standby-state	Tier 2017 (1.1.2017-31.12.2017) (W)	Tier 2018 (1.1.2018-31.12.2018) (W)
VDSL2 (Note 18.1)	0.5	0.5
G.fast for DPUs up to 16 ports (Note 18.1)	N/A	N/A

Notes:

(18.1) DSL-standby-state corresponds to the L3-Idle state as defined in ITU-T Rec G.993. 2 [18]. G.fast-standby-state corresponds to the L3-Idle state as defined in ITU-T Rec G.9701 [23]. Stand-by targets do not apply to the Vectoring capable VDSL2 or Vectoring capable G.fast.

The above values for DSL-low-power and -standby-states are for fully equipped, maximum configuration DSLAMs with more than 128 ports. For equipment up to 128 ports (and with maximum configuration) 0.15W per line may be added to the above values for the whole DSLAM, with a minimum value of 5W.

The above G.fast values apply to fully equipped, maximum configuration DPUs within each category (single line, small, large or very large multiline). These numbers assume no extra allowance for <=128 lines and no extra allowance for vectoring.

To minimize cost, dimensions, and power consumption, the network equipment contains chips that control multiple DSL lines (4-8-16) each. If special care is not taken, a single line in DSL-full-load-state could result in a chip fully operational on the other lines also (in low-power or standby states), resulting in an unnecessary waste of energy. The network systems (and their basic components) shall therefore be designed in order to tackle this issue, maximizing the energy savings also in mixed environments with lines in different power states, being this the typical situation found in the network.

MELT-stand-by state is defined as the state in which the Metallic Line Testing entity (MELT) is in IDLE mode, i.e., inactive, connected in parallel to the broadband port on the DSLAM and provisioned for line testing. MELT standby targets are additional allowances on top the power consumption targets defined for each of DSL operating states.

Table 18a: Broadband ports – MELT-stand-by state

Power targets for MELT-standby state	Tier 2017 (1.1.2017-31.12.2017) (mW)	Tier 2018 (1.1.2018-31.12.2018) (mW)
VDSL2	+30	+30

An additional allowance for each uplink interface (applicable for all power states: full-load, low-power and standby) is defined below:

Table 18b: Uplink Interfaces

Uplink Interfaces	Tier 2017 (1.1.2017 - 31.12.2017) (W)	Tier 2018 (1.1.2018 - 31.12.2018) (W)
PtP 1000Mbit/s (Energy Efficient Ethernet)	2,0	1,8
PtP 10Gbit/s (Energy Efficient Ethernet)	6,0	5,5
PON (GPON)	4,0	3,7
PON (1G-EPON)	2,0	1,8
PON (10/1G-EPON)	5,0	4,6
PON (10/10G-EPON)	6,0	5,5

C.2.2 Combined DSL/Narrowband network equipment

Power consumption limits for POTS interface implementation into an MSAN are defined in Table 19. The values defined apply to a testing condition where the line length equivalent resistance (including the CPE resistance) is assumed to be 510 Ohm.

It is further assumed that power consumed by MSAN functionality, which is common to both Broadband DSL and POTS is split appropriately across the two functions. For those boards, such as combo interface board and combo main control board, which integrate Broadband DSL and POTS functions, the power consumption of these boards are to be measured separately for each function, i.e., measure Broadband DSL with POTS disabled and vice versa. In case the two functions cannot be fully disabled separately, the power values for each function can be declared in proportion according to the measured total power values.

Table 19: Per-port MSAN POTS power consumption limits

Per-port MSAN POTS power consumption limits in Watt	**Tier 2017 (1.1.2017-31.12.2017)**				**Tier 2018 (1.1.2018-31.12.2018)**			
	PortState line feed (W)				**PortState line feed (W)**			
PortState	**40mA**	**32mA**	**25mA**	**20mA**	**40mA**	**32mA**	**25mA**	**20mA**
Not provisioned for POTS | Notes 19.1, 19.2	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
Provisioned for POTS - on-hook | Notes 19.1, 19.3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
Provisioned for POTS - off-hook | Note 19.1	2,6	1,9	1,6	1,5	2,6	1,9	1,6	1,5

Notes:

(19.1) These figures are additive to those existing in the code of conduct section C.2(network equipment) for Broadband DSL to form the per port limit for combo operation.

(19.2) Note that this assumes that the port is equipped to supply POTS but has not been configured for use by an end customer.

(19.3) Note that this excludes any on-hook charging current, which may be drawn by the CPE (up to 3mA in some countries).

The above values are for fully equipped, maximum configuration MSAN with more than 128 ports. For equipment up to 128 ports (and with maximum configuration) 0.15 W per line may be added to the above values for the whole MSAN, with a minimum value of 5 W.

It is further assumed that power consumed by MSAN functionality which is common to both Broadband DSL and POTS is split appropriately across the two functions. For those boards, such as combo interface board and combo main control board, which integrate Broadband DSL and POTS functions, the power consumption of these boards are to be measured separately for each function, i.e., measure Broadband DSL with POTS disabled and vice versa. In case the two functions cannot be fully disabled separately, the power values for each function can be declared in proportion according to the measured total power values.

An additional allowance for each uplink interface is available from Table 18b.

C.2.3 Optical Line Terminations (OLT) for PON and PtP networks

Table 20: Optical Line Terminations for PON ports

	<= 32 PON ports		**> 32 PON ports**	
Power targets for Optical Line Terminations for PON ports	**Tier 2017 (1.1.2017-31.12.2017) (W)**	**Tier 2018 (1.1.2018)-(31.12.2018) (W)**	**Tier 2017 (1.1.2017-31.12.2017) (W)**	**Tier 2018 (1.1.2018)-(31.12.2018) (W)**
GPON (2.5G/1G)				
OLT (GPON, fully equipped with maximum configuration implementing standard Layer-2 (Ethernet) aggregation functionalities, including Multicast)	6,0	5,0	5,6	4,5
OLT (GPON, fully equipped with maximum configuration implementing also functionalities at the IP layer such as routing, MPLS, and IP QoS)), or more advanced Layer 2 functionality (QOS, shaping, policing)	6,5	5,5	6,0	5,0
XG-PON1 (10G/2.5G) | Note 20.1				
OLT (XG-GPON1 10G/2.5G, fully equipped with maximum configuration implementing standard Layer-2 (Ethernet) aggregation functionalities, including Multicast)	15,0	11,0	13,0	9,0
OLT (XG-GPON1 10G/2.5G, fully equipped with maximum configuration implementing also functionalities at the IP layer such as routing, MPLS, and IP QoS), or more advanced Layer 2 functionality (QOS, shaping, policing).	18,0	12,0	15,0	10,0
Additional per port allowance for 10G GPON and 10G EPON OLT, with independent traffic process component (not embedded in PON MAC) on each line cards, implementing Layer 3 functionalities of Edge Router (at least IP/MPLS routing and interface and policy based hierarchical QoS (H-QoS)), providing extendable capability to evolve adding new functionalities	5,0	2,0	5,0	2,0

	<= 32 PON ports		> 32 PON ports	
Power targets for Optical Line Terminations for PON ports	**Tier 2017 (1.1.2017-31.12.2017) (W)**	**Tier 2018 (1.1.2018)-(31.12.2018) (W)**	**Tier 2017 (1.1.2017-31.12.2017) (W)**	**Tier 2018 (1.1.2018)-(31.12.2018) (W)**
currently under discussion, and variable traffic processing functions and/or market specific customization requirements.				
EPON (1G/1G)				
OLT (1G-EPON, fully equipped with maximum configuration implementing standard Layer-2 (Ethernet) aggregation functionalities, including Multicast)	5,9	5,0	5,5	4,5
OLT (1G-EPON, fully equipped with maximum configuration implementing also functionalities at the IP layer such as routing, MPLS, and IP QoS), or more advanced Layer 2 functionality (QOS, shaping, policing)	6,4	5,5	6,0	5,0
10G/1G EPON | Note 20.1				
OLT (10/1G-EPON, fully equipped with maximum configuration implementing standard Layer-2 (Ethernet) aggregation functionalities, including Multicast)	15,5	11,0	12,6	9,0
OLT (10/1G-EPON, fully equipped with maximum configuration implementing also functionalities at the IP layer such as routing, MPLS, and IP QoS), or more advanced Layer 2 functionality (QOS, shaping, policing)	16,8	12,0	13,4	10,0
Additional per port allowance for 10G GPON and 10G EPON OLT, with independent traffic process component (not embedded in PON MAC) on each line cards, implementing Layer 3 functionalities of Edge Router (at least IP/MPLS routing and interface and policy based hierarchical QoS (H-QoS)), providing extendable capability to evolve adding new functionalities currently under discussion, and variable traffic processing functions and/or	5,0	2,0	5,0	2,0

	<= 32 PON ports		> 32 PON ports	
Power targets for Optical Line Terminations for PON ports	**Tier 2017 (1.1.2017-31.12.2017) (W)**	**Tier 2018 (1.1.2018)-(31.12.2018) (W)**	**Tier 2017 (1.1.2017-31.12.2017) (W)**	**Tier 2018 (1.1.2018)-(31.12.2018) (W)**
market specific customization requirements				
10G/10G EPON | Note 20.1				
OLT (10/10G-EPON, fully equipped with maximum configuration implementing standard Layer-2 (Ethernet) aggregation functionalities, including Multicast)	16,6	13,0	14,0	11,0
OLT (10/10G-EPON, fully equipped with maximum configuration implementing also functionalities at the IP layer such as routing, MPLS, and IP QoS), or more advanced Layer 2 functionality (QOS, shaping, policing)	17,8	14,0	14,5	12,0
Additional per port allowance for 10G GPON and 10G EPON OLT, with independent traffic process component (not embedded in PON MAC) on each line cards, implementing Layer 3 functionalities of Edge Router (at least IP/MPLS routing and interface and policy based hierarchical QoS (H-QoS)), providing extendable capability to evolve adding new functionalities currently under discussion, and variable traffic processing functions and/or market specific customization requirements	5,0	2,0	5,0	2,0

Notes:

(20.1) The state of maturity of this technology is such that power targets can only apply to OLTs with the fiber technology implemented in ASIC. Signatories must report the power consumptions values of any OLT equipment that they manufacture or deploy, so that the state of development of this technology can be taken into account when revising these targets in the future. For OLTs with the fiber technology not implemented in ASIC, such report will not be included in the assessment of whether or not the 90% target has been achieved.

Table 21: Optical Line Terminations for PtP ports

Power targets for Optical Line Terminations for PtP ports	Tier 2017 (1.1.2017-31.12.2017) (W)	Tier 2018 (1.1.2019-31.12.2018) (W)
PtP 1000Mbps		
OLT (PtP up to 1000 Mbit/s, up to 100 ports, fully equipped with maximum configuration)	4,0	2,8
OLT (PtP up to 1000 Mbit/s, from 100 and 300 ports, fully equipped with maximum configuration)	2,7	2,4
OLT (PtP up to 1000 Mbit/s, with more than 300 ports, fully equipped with maximum configuration)	1,9	1,7
Additional per port allowance for PtP up to 1000 Mbit/s OLT, with independent traffic process component (not embedded in LAN switch) on each line cards, implementing Layer 3 functionalities of Edge Router (at least IP/MPLS routing and interface and policy based hierarchical QoS (H-QoS)), providing extendable capability to evolve adding new functionalities currently under discussion, and variable traffic processing functions and/or market specific customization requirements	0,3	0,3
PtP 10Gbps		
OLT (PtP at 10 Gbit/s, up to 16 ports, fully equipped with maximum configuration)	27	18
OLT (PtP at 10 Gbit/s, from 16 to 48 ports, fully equipped with maximum configuration)	19	13
OLT (PtP at 10 Gbit/s, with more than 48 ports, fully equipped with maximum configuration)	12	8

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

An additional allowance for each uplink interface is available from Table 18b:

The above consumption for GPON, XG-PON1 and EPON OLT is per port whatever the number of ONU connected to it is. The above consumption for GPON OLT is with Class B+ (ITU-T G.984.2 amd1) optical modules.

The above consumption for PtP OLT is per user port. The optical budget for the OLT P2P interfaces shall be in line with IEEE 802.3, Clause 58 for the 100BASE-LX10 and 100BASE-BX10 interfaces and IEEE 802.3, Clause 59 for the 1000BASE-LX10 and 1000BASE-BX10 interfaces. The PtP 10 Gbit/s limits are applicable only to PtP links operating at 10 Gbit/s, fully equipped with maximum configuration that directly connect to CPE associated with broadband distribution for residential customers and SOHO.

The above power consumption for EPON OLT is per port and with PRX30 class for 10/1G-EPON OLT, PR30 class for 10/10G-EPON and PR30 class for 1G-EPON [12].

C.2.4 Wireless Broadband network equipment

Table 22: Wi-Fi network equipment

Power targets for Wi-Fi network equipment	Tier 2017 (1.1.2017-31.12.2017) (W)	Tier 2018 (1.1.2018-31.12.2018) (W)
Wi-Fi access points (Hotspot application) 802.11b/g/n or 802.11/b/g/a – ON state and Active Standby | Note 22.1	8	8

Notes:

(22.1) The On-state is defined with no traffic on the Wi-Fi port. Therefore there is no difference in power consumption between the On-state and the Low-load-state (Active Standby) for this equipment.

Table 23: WiMAX network equipment

Power targets for WiMAX network equipment	Tier 2017 (1.1.2017-31.12.2017) (W)		Tier 2018 (1.1.2018-31.12.2018) (W)	
	2,5 GHz	3,5 GHz	2,5 GHz	3,5 GHz
WiMAX Radio Base Station (3 sectors) – Busy-hour-load-state	510	480	510	480
WiMAX Radio Base Station (3 sectors) – Medium-load-state	440	420	440	420
WiMAX Radio Base Station (3 sectors) – Low-load-state	355	340	355	340

Configuration of WiMAX Radio Base Station:

1) 3 sectors, 2,5 GHz/3,5 GHz, 10 MHz bandwidth channel, 4 × 4 MIMO, 29:18 DL/UL subframe ratio
2) Output power: 28 W (7 W × 4) (3,5 GHz) / 40 W (10 W × 4) (2,5 GHz) at antenna interface for each sector

For WiMAX Radio base station the following states are differentiated:

Busy-hour-load-state is the operating mode of the equipment or device where it provides maximum capacity and RF transmit with the maximum output power.

Medium-load-state is the operating mode of the equipment or device where RF transmits with the 50% DL symbol.

Low-load-state is the idle mode of the equipment or device where it works with no traffic and only transmits the Preamble and MAP.

Table 24: GSM/EDGE network equipment

Power targets for GSM/EDGE network equipment	Tier 2017 (1.1.2017-31.12.2017) (W)	Tier 2018 (1.1.2018-31.12.2018) (W)
	0,9/1,8/1,9 GHz	0,9/1,8/1,9 GHz
Nominal output power of Radio Unit <= 80W		
GSM/EDGE Radio Base Station – Busy-hour-load-state	760	760
GSM/EDGE Radio Base Station – Medium-load-state	650	625
GSM/EDGE Radio Base Station – Low-load-state	540	520
Nominal output power of Radio Unit > 80W		
GSM/EDGE Radio Base Station – Busy-hour-load-state	855	855
GSM/EDGE Radio Base Station – Medium-load-state	700	700
GSM/EDGE Radio Base Station – Low-load-state	585	585

Notes:

1) Three sectors, four carriers per sector (S444). Nominal output power of Radio Unit: <= 80W and > 80W.

2) Output power: 20W at antenna interface for each carrier (4 × 20W for each sector).

For GSM/EDGE Radio base station the busy hour load, medium load and low load states defined in ETSI ES 202 706 v.1.4.1 [10] shall be used.

Table 25: WCDMA/HSDPA network equipment

Power targets for WCDMA/HSDPA network equipment	Tier 2017 (1.1.2017-31.12.2017) (W)	Tier 2018 (1.1.2018-31.12.2018) (W)
	2,1 GHz	2,1 GHz
Nominal output power of Radio Unit <= 80W		
WCDMA/HSDPA Radio Base Station – Busy-hour-load-state	760	725
WCDMA/HSDPA Radio Base Station – Medium-load-state	650	600
WCDMA/HSDPA Radio Base Station – Low-load-state	540	505

Nominal output power of Radio Unit > 80W		
WCDMA/HSDPA Radio Base Station – Busy-hour-load-state	795	795
WCDMA/HSDPA Radio Base Station – Medium-load-state	660	660
WCDMA/HSDPA Radio Base Station – Low-load-state	555	555

Notes:

1) Three sectors, two carriers per sector (S222). Nominal output power of Radio Unit: <= 80W and > 80W.
2) Output power: 20W at antenna interface for each radio cell (20W+ 20W for each sector).

For WCDMA/HSDPA Radio base station the states are differentiated (the state definitions are based on defined in ETSI ES 202 706 v.1.4.1 [10] shall be used.

Table 26: Wireless broadband network equipment – LTE

Power targets for LTE wireless broadband network equipment	Tier 2017 (1.1.2017-31.12.2017) (W)	Tier 2018 (1.1.2018-31.12.2018) (W)
Nominal output power of Radio Unit <= 80W		
LTE Radio Base Station – Busy-hour-load-state	840	790
LTE Radio Base Station – Medium-load-state	700	660
LTE Radio Base Station – Low-load-state	600	565
Nominal output power of Radio Unit > 80W		
LTE Radio Base Station – Busy-hour-load-state	870	870
LTE Radio Base Station – Medium-load-state	725	725
LTE Radio Base Station – Low-load-state	620	620

Configuration of LTE Radio Base Station:

1) 3 sectors, 2,6 GHz, 20 MHz bandwidth channel 2 × 2MIMO. Nominal output power of Radio Unit: <= 80W and > 80W.
2) Output power: 40W (20W × 2) at antenna interface for each sector.

For LTE Radio base station the states are differentiated (the state definitions are in ETSI ES 202 706v.1.4.1 [10] shall be used [10]).

C.2.5 Cable Network Equipment

Cable network system vendors have developed the new Converged Cable Access Platform (CCAP) which incorporates multiple headend functionalities into a single piece of equipment. Suitable power metrics and targets for this equipment are now included in the Code of Conduct. Deployment of CCAP systems is currently replacing I-CMTS and M-CMTS equipment and this trend will continue throughout the next several years. Therefore investment in future power efficiency enhancements to legacy CMTS technology is not expected.

Table 27: Cable Network Equipment Definitions

CCAP	The Converged Cable Access Platform (CCAP) provides the layer 2 and layer 3 data forwarding services of a traditional CMTS and the video processing and modulation functions of an edge-QAM into a single platform. A CCAP can also support Ethernet Passive Optical Network (EPON) functionality, providing DOCSIS Provisioning of EPON (DPoE) services through access-side PON interfaces. The CCAP supports video services in the downstream and DOCSIS services in the downstream and upstream directions. The CCAP is a full RF spectrum device, allowing 120 8-MHz QAM channels to be placed on the downstream for video and DOCSIS 3.0 services. In addition, the CCAP supports DOCSIS 3.1, allowing wider OFDM channels to be placed within the downstream spectrum. In the upstream, both DOCSIS 3.0 and 3.1 channels (OFDMA channels) are supported. The platform is designed to be ultra-dense, meaning that the number of downstream RF interfaces in a CCAP is much greater than the number supplied on traditional headend equipment. The platform has a mid-plane architecture with active, replaceable line cards for data processing connected across the mid plane to passive physical interface cards (PICs) with RF interfaces. This allows line card redundancy and failover, as well as allowing line cards to be replaced without disconnecting cables from the RF interfaces on the PICs. The combination of video and data processing, as well as the RF density of the CCAP, reduces the amount of equipment needed in the headend (CMTS, edge-QAM, and combining network). Two useful entities are commonly used to characterize the essence of a CCAP. The first is the concept of a Service Group. A Service Group, for the purpose of this document, is defined as a subset of a CCAP chassis consisting of a single downstream RF port and two corresponding upstream RF ports or a single downstream RF port and a single corresponding upstream RF port. Multiple Service Groups are supported by a CCAP chassis with each Service Group typically serving about 500 to 1500 homes. The second useful entity associated with a CCAP is the aspect of its data throughput, typically expressed in Gbps. This stems from the fact that a CCAP is

	fundamentally a routing platform. Since a CCAP implementation may not have symmetrical downstream/upstream throughput capabilities, throughput is often expressed as "downstream throughput" and separately as "upstream throughput". Note that modular CCAP and generations of CCAP equipment specifically targeted for Distributed Access Architectures (DAA) are out of scope for this document.
I-CMTS	(Legacy equipment) A Cable Modem Termination System (CMTS) forwards (at layer 2 or layer 3) data packets between a wide area network via its Network-side interfaces and customer premise equipment via its DOCSIS RF interface ports. In the case of an Integrated CMTS (I-CMTS), the downstream (DS) RF interfaces, upstream (US) RF interfaces, Network –side interfaces and associated control plane and data plane processing entities all reside within a single piece of equipment. An I-CMTS does not support, nor was it designed to support, MPEG video transport.
M-CMTS	(Legacy equipment) In the case of a multi-unit, distributed-equipment CMTS (an M-CMTS), the interfaces and associated control plane and data plane processing entities are distributed among multiple pieces of equipment. The first of these, called an M-CMTS Core, is comprised of the upstream RF interfaces and the Network-side interfaces. All upstream and network-side control plane and data plane processing for those interfaces is also handled by the M-CMTS Core. Downstream MAC-layer processing is also performed on the M-CMTS Core. A separate piece of equipment, the Edge-QAM, contains the M-CMTS downstream RF interface ports as well as network-side interfaces. The M-CMTS Core transmits downstream data content and control to the Edge-QAM across the Converged Interconnect Network (CIN) via the DOCSIS-defined DEPI interface (which is a form of an IP tunnel). The Edge-QAM then performs the downstream physical-layer processing necessary to modulate and transmit the data content of the downstream channel onto downstream RF port(s) toward the CM and CPE devices on the HFC network. A third component, the DOCSIS Timing Server provides a common sense of timing and frequency to the other M-CMTS components via the DOCSIS Timing Interface (DTI).

C.2.5.1 CCAP Equipment

C.2.5.1.1 CCAP Power Consumption Metric

The two metrics below are to be used to evaluate the power consumption characteristics of CCAP equipment. It is important to note that evaluation and consideration of both metrics is required in order to ensure a comprehensive understanding of these characteristics.

C.2.5.1.2 CCAP Power Consumption per Service Group

The *CCAP power consumption per Service Group* shall be determined with the metric specified in [29] – section 8.2.1.

C.2.5.1.3 CCAP Power Consumption per Throughput

The *CCAP power consumption per Throughput* shall be determined as specified in [29] – section 8.2.2.

C.2.5.1.4 CCAP Power Consumption – Configuration

The configuration and test procedures specified in [29] – sections 10.1, 10.2, 10.3, 10.5, and 10.8 (and their subsections) shall be applied in the evaluation of the CCAP power consumption metrics of section . The general testing standards and configuration specified in [28] shall also be applied. Note that configuration includes redundancy if supported by the CCAP equipment under test per [29] – section 10.2.

C.2.5.1.5 CCAP Power Consumption – Allowances

Table 28: CCAP Power Consumption per Service Group

Power targets for CCAP equipment	**Scenario A (2015 – 2017)** **1 DS, 2 US RF Ports per Service Group** **(Watts / Service Group)**	**Scenario B (2015 – 2017)** **1 DS, 1 US RF Ports per Service Group** **(Watts / Service Group)**	**Scenario C (2018 – 2020)** **1 DS, 2 US RF Ports per Service Group** **(Watts / Service Group)**
CCAP Power per SG: 70% Utilization	130 W	130 W	115 W

Table 29: CCAP Power Consumption per Throughput

Power targets for CCAP equipment	**Scenario A (2015 – 2017)** **1 DS, 2 US RF Ports per Service Group** **(Watts / Gbps)**	**Scenario B (2015 – 2017)** **1 DS, 1 US RF Port per Service Group** **(Watts / Gbps)**	**Scenario C (2018 – 2020)** **1 DS, 2 US RF Ports per Service Group** **(Watts / Gbps)**
CCAP Power per Throughput	100 W	100 W	50 W

C.2.5.2 Other Cable Network Equipment

Table 30: Cable network equipment

Power targets for cable network equipment	**Tier 2017 (1.1.2017-31.12.2017) (W/channel)**	**Tier 2018 (1.1.2018-31.12.2018) (W/channel)**
I-CMTS	6	6
M-CMTS Core	6	6
Edge-QAM	3	3

An allowance of 4.5 W is provided for each Ethernet Point-to-Point 1 Gbit/s interface for M-CMTS Core and Edge-QAM. An allowance of 8 W is provided for each M-CMTS Ethernet Point-to-Point 10 Gbit/s interface for M-CMTS core and Edge-QAM.

The above values are nominal at 25° C per downstream channel (or QAM) for a fully equipped chassis at its maximum configuration. Sparing features are not assumed. The assumed configuration for I-CMTS and M-CMTS Core includes a ratio of two upstream Service Groups paired with one downstream Service Group. It is assumed that the ratio of number of channels in an upstream Service Group to number of channels in a downstream Service Group is 1:4. For Edge-QAM, the assumed configuration is that all QAM channels are configured as DOCSIS downstream channels. These power numbers reflect the total chassis power divided by the number of downstream channels.

The optional DOCSIS Timing Interface (DTI) Server in an M-CMTS configuration is expected to consume at most 80 W.

D. EXAMPLE HOME GATEWAY POWER CONSUMPTION TARGETS

The home gateway power consumption targets are computed from the components according to the configuration (profile) of the home gateway. Some example profiles are provided below. Home gateways having these exact configurations must meet these power targets, and by using this approach it is possible to create the targets that must be met for a home gateway of arbitrary functionality.

D.1 ADSL Home Gateway

ADSL home gateway with 4 Fast Ethernet LAN ports, a single radio IEEE 802.11b/g Wi-Fi interface and 2 USB 2.0 ports:

- in idle-state: all Ethernet LAN ports disconnected, no traffic on Wi-Fi
- in on-state: all Ethernet LAN ports active, traffic on Wi-Fi

Function	idle-state		on-state	
	2017	**2018**	**2017**	**2018**
Central functions + ADSL WAN interface	2,2	2,0	2,8	2,4
4 Fast Ethernet LAN ports	4 × 0,2 = 0,8	4 × 0,2 = 0,8	4 × 0,3 = 1,2	4 × 0,3 = 1,2
single radio IEEE 802.11b/g Wi-Fi interface (23 dBm EIRP)	0,7	0,7	1,3	1,2
USB 2.0 ports	2 × 0,1 = 0,2	2 × 0,1 = 0,2	2 × 0,1 = 0,2	2 × 0,1 = 0,2
Total equipment	**3,9W**	**3,7W**	**5,5W**	**5,0W**

D.2 VDSL2 Home Gateway

VDSL2 home gateway with 4 Gigabit Ethernet LAN ports, a single radio 802.11n Wi-Fi interface, 2 USB 2.0 ports and 2 FXS ports:

- in idle-state: all Ethernet LAN ports disconnected, no traffic on Wi-Fi, no voice call
- in on-state: all Ethernet LAN ports active, traffic on Wi-Fi, 1 active voice call (the second FXS port has no device connected and for this port the idle target needs to be considered)

Function	idle-state		on-state	
	2017	**2018**	**2017**	**2018**

Function	idle-state		on-state	
	2017	2018	2017	2018
Central functions + VDSL2 WAN interface (17a)	3,2	3,0	4,0	3,7
4 Gigabit Eth. LAN ports	4 × 0,2 = 0,8	4 × 0,2 = 0,8	4 × 0,4 = 1,6	4 × 0,4 = 1,6
single IEEE 802.11n radio Wi-Fi interface with 3 RF chains 3x3 MIMO (23 dBm)	0,8+0,1 = 0,9	0,8+0,1 = 0,9	2,0+0,3 = 2,3	1,8+0,3 = 2,1
USB 2.0 ports	2 × 0,1 = 0,2	2 × 0,1 = 0,2	2 × 0,1 = 0,2	2 × 0,1 = 0,2
FXS ports	2 × 0,2 = 0,4	2 × 0,2 = 0,4	1,0+0,2 = 1,2	0,9+0,2 = 1,1
Total equipment	**5,5W**	**5,3W**	**9,3W**	**8,7W**

D.3 Ethernet router with 4 Fast Ethernet LAN ports

Fast Ethernet router with 1 WAN and 4 LAN Ethernet ports:

Function	idle-state		on-state	
	2017	2018	2017	2018
Central functions + Fast Ethernet WAN interface	1,5	1,4	2,0	1,7
4 Fast Ethernet LAN ports	4 × 0,2 = 0,8	4 × 0,2 = 0,8	4 × 0,3= 1,2	4 × 0,3 = 1,2
Total equipment	**2,3W**	**2,2W**	**3,2W**	**2,9W**

D.4 Cable DOCSIS 3.0 CPE

DOCSIS 3.0 CPE in 8x4 configuration with 1 Gigabit Ethernet LAN port:

Function	idle-state		on-state	
	2017	2018	2017	2018
Central functions + DOCSIS 3.0 basic configuration WAN interface	5,2	5,2	6,2	5,7
1 DOCSIS 3.0 Additional power allowance for the additional 4 downstream channels	2,0	1,3	2,5	2,0
1 Gigabit Ethernet LAN port	0,2	0,2	0,4	0,4
Total equipment	**7,4W**	**6,7W**	**9,1W**	**8,1W**

D.5 Complex HNID

Dual-band 11n access point with 4 Gigabit Ethernet LAN ports:

Function	idle-state		on-state	
	2017	2018	2017	2018

Function	idle-state		on-state	
	2017	**2018**	**2017**	**2018**
Wi-Fi Access Points with single band IEEE 802.11n radio (23 dBm), 2x2 MIMO	2,1	1,9	3,3	2,7
single IEEE 802.11n radio Wi-Fi interface (23 dBm), 2x2 MIMO	0,8	0,8	2,0	1,8
3 additional Gigabit Ethernet LAN ports	3 × 0,2 = 0,6	3 × 0,2 = 0,6	3 × 0,4 = 1,2	3 × 0,4 = 1,2
Total equipment	**3,5W**	**3,3W**	**6,5W**	**5,7W**

E. REPORTING FORM

See Reporting Sheet on the homepage of the EU Standby Initiative [3].

The reporting spreadsheet should be filled in on the basis of equipment capability, in particular the actual number of ports on cards or chassis should be entered, regardless of any design or regulatory constraints which may result in the suboptimal use of those cards.

For Network Operators, the tier to be used for compliance purposes should be that pertaining to the year when equipment of a given type was ordered for the first time.

F. TEST METHODS

F.1 Customer premises equipment

Customer premises equipment with an external power supply shall be measured 230V AC input in all states (when existing) as they are described in section B.1. In the future, standardization bodies like ETSI could provide a more detailed specification for the measurement of the power consumption in different states.

F.2 Network equipment

The values given in section C.2 are indicating the averaged power consumption per port for a fully equipped system as delivered by the manufacturer.

Systems powered by DC voltage shall comply with the standard ETSI EN 300 132-2 [8].

The method of power measurement of equipment in line with point 0, C.2.2 and C.2.3 shall comply with the Technical Specification ETSI EN 303 215 [27]. The method of power measurement for equipment in line with point C.2.4 shall comply with the Technical Specification ETSI TS 202 706 static mode [16].

In case of systems powered directly by AC mains voltage, the power consumption will have to be measured at the AC input. For AC mains powered systems, the power limits stated in Table 16 through Table 26 are increased by 10%. In case of integrated remote or reverse powered systems, the power limits stated are increased by 15% for remote and 30% for reverse powered systems.

The power limits have to be fulfilled for the system operating at ambient temperature (25 ± 2° C). Fans, if present in network equipment in line with points 0 and C.2.2, have to be set at maximum speed.

Note: for both Customer premises and network equipment the xDSL test conditions under which energy consumption is measured should be representative of the scenario(s) under which network equipment or CPE is to be deployed (e.g., selection of band plan for VDSL2).The Broadband Forum and ETSI EE provide xDSL test plans, which may be used prior to the general availability of a unified test methodology which is fully compatible with the Code of Conduct.

In the spirit of industry harmonization, ETSI EE and the Broadband Forum will collaborate on the review/definition of the Broadband Energy efficiency measurement methods standards and test plans for xDSL CPE and network equipment published by ETSI with the aim of making joint recommendations for the next revision of the Code of Conduct.

G. EVOLUTION OF POWER SAVING FOR BROADBAND EQUIPMENT

The volume of deployed broadband equipment is increasing dramatically and so does its combined power consumption. Due to low customer aggregation ratios (typically, one CPE per customer), such equipment is typically idle most of the time, most of the time exchanging data only to maintain its network status. It is therefore evident that such equipment can be optimized in terms of its power consumption and activity profiles. Examples of such techniques include dynamic adaptation (e.g., performance scaling), smart standby (e.g., through proxying network presence and virtualization of functions) and energy aware management. The following list gives an overview of some of available optimization techniques.

- Energy Efficient Ethernet (EEE) as defined in IEEE Std 802.3-2012 SECTION SIX – wired copper Ethernet interfaces on CPEs have the ability to operate at a data rate lower than their nominal data rate, reducing power consumption of the interface as a whole. Different port-type-specific signalling mechanisms are used in EEE, including Low Power Idle. To take the full advantage of the EEE potential, both link peers must support EEE.
- Network Proxying defined by the ECMA task group under the work programme of TC38-TG4 - Proxying Support for Sleep Modes. The work is focused on providing support for the Network Proxy function for various types of broadband equipment, including VoIP phones. A proxy in this context is an entity that maintains network presence for a sleeping higher-power broadband device. A VoIP phone remains idle most of the time. VoIP phones cannot be put into a full standby mode, since they are required to maintain network presence through persistent data connectivity. Through proxying, another entity within the broadband network can assure such persistent data connectivity on behalf of a VoIP phone and wake it up when required. In this way, a device can enter a full standby mode, without any adverse effects on associated communication protocols.
- Energy aware management IETF EMAN. Provides a framework for Energy Management for devices within or connected to communication networks, and components thereof. It defines an Energy Management Domain as a set of Energy Objects, for which each Energy Object is identified, classified and given context. Energy Objects can be monitored and/or controlled with respect to Power, Power State, Energy, Demand, Power Quality, and battery. https://datatracker.ietf.org/wg/eman/
- Energy aware management within ETSI - The Green Abstraction Layer (GAL) is an architectural interface/middleware that intends to give a flexible access to the power management capabilities of the future energy aware BroadBand nodes to effectively exploit the capability of adapting their energy consumption with respect to the function (typically the traffic) variations. The GAL aims at synthetizing and at correctly exposing power management capabilities and corresponding consumption variation.

Implementing those functions in broadband equipment enhances its capabilities for power saving.

H. LIST OF ABBREVIATIONS

1G-EPON	EPON operating at 1 Gbit/s downstream and 1Gbit/s upstream (IEEE 802.3)
10/1G-EPON	EPON operating at 10 Gbit/s downstream and 1Gbit/s upstream (IEEE 802.3)
10/10G-EPON	EPON operating at 10 Gbit/s downstream and 10Gbit/s upstream (IEEE 802.3)
ADSL	Asymmetric Digital Subscriber Line
ADSL2plus	Second generation ADSL with extended bandwidth
ATA	Analogue Terminal Adapter
CCAP	Converged Cable Access Platform
CoC	Code of Conduct
COP	Coefficient Of Performance
CPE	Customer Premises Equipment
DECT	Digital Enhanced Cordless Telecommunications
DOCSIS	Data Over Cable Service Interface Specification
DPU	Distribution Point Unit
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
EPON	Ethernet Passive Optical Network, as specified by IEEE 802.3
ETSI	European Telecommunications Standards Institute
FXO	Foreign eXchange Office
FXS	Foreign eXchange Station
GPON	Gigabit Passive Optical Network
GSM/EDGE	Global System for Mobile communication/Enhanced Datarate GSM Evolution
HPNA	Home PNA Alliance
IEEE	Institute of Electrical and Electronics Engineers
I-CMTS	Integrated Cable Modem Termination System
IP	Internet Protocol
ITU	International Telecommunication Union
LAN	Local Area Network
LT	Line Termination
LTE	Long Term Evolution
M-CMTS	includes CMTS core and EQAM (Edge Quadrature Amplitude Modulator)
MoCA	Multimedia over Coax Alliance
MSAN	Multi-Service Access Node
NAT	Network Address Translation
NT	Network Termination
ONU	Optical Network Unit
PtP	Point-to-Point Optical Network
PLC	PowerLine Communication
PoE	Power over Ethernet
PON	Passive Optical Network
POTS	Plain Old Telephone Service
SOHO	Small Office, Home Office
USB	Universal Serial Bus
VDSL2	Very High Speed Digital Subscriber Line 2nd generation
VoIP	Voice over IP
WAN	Wide Area Network
WCDMA/HSDPA	Wideband Code Division Multiple Access/High Speed Packet Access
Wi-Fi	Wireless Fidelity; technology using IEEE 802.11 standards
XG-PON1	10-Gigabit passive optical network

I. LIST OF REFERENCES

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J. SIGNING FORM

Code of Conduct
On Energy Consumption of Broadband Equipment

SIGNING FORM

The organisation/company/
……………………………………………………………………………………
signs the Code of Conduct on Energy Consumption of Broadband Equipment and commits itself to abide to the principles described in point 3 "Commitment" for the equipment it produces, buys, installs or specifies.

The organisation, through regular upgrade reports, will keep the European Commission informed on the implementation of the Code of Conduct of Broadband Equipment.

for the organisation

Director or person authorised to sign:
Name: …………………………………………………
Managerial Function: …………………………………………………
Address: …………………………………………………
Tel. / Fax: …………………………………………………
Email: …………………………………………………
Date: …………………………………………………

Signature …………………………………………………

Please send the signed form to:

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