



EUROPEAN COMMISSION
JOINT RESEARCH CENTRE
Institute for Energy and Transport
Renewable Energy Unit

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Ispira, 20th December 2013

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Code of Conduct

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on Energy Consumption of Broadband Equipment

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Version 5.0

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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 up to 50 TWh per year can be estimated for the year 2015. With the general principles and actions resulting from the implementation of this Code of Conduct the (maximum) electricity consumption could be limited to 25 TWh per year, this is equivalent to 5,5 Million tons of oil equivalent and to total saving of about € 7,5 Billion per year.

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. 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.

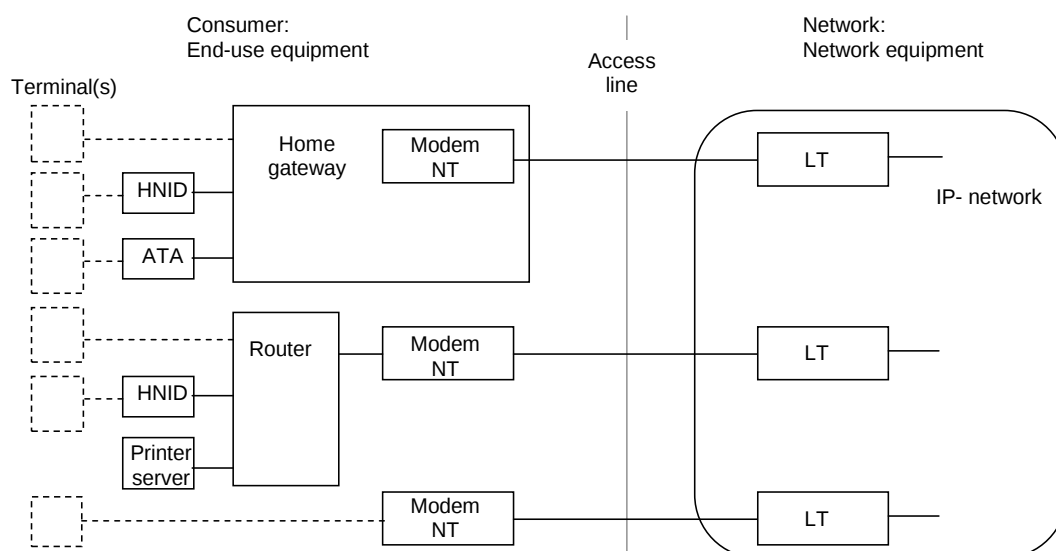


Figure 1: Examples of configurations

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, and VDSL2 with G.993.5 (Vectoring) support) • Cable CPEs (DOCSIS 2.0 and 3.0) • Optical CPEs (PON and PtP) • Ethernet router CPEs

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

Simple broadband access devices:

- DSL CPEs powered by USB
- Layer 2 ONUs

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)
- Print server

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:
 - Works only with other dedicated proprietary controlling device/server.
 - 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, and VDSL2) • 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 or WiMAX Radio Base Station)

- | |
|---|
| <ul style="list-style-type: none">• Cable service provider equipment• Powerline service provider equipment |
|---|

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 number¹) of the new-model items of broadband equipment 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 brought to market 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 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.

¹ For network equipment ‘by number’ means ‘by number of ports’, so as to allow for equipment with very different numbers of ports.

188 **4. MONITORING**

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

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

- 196 a) Evaluate the level of compliance and the effectiveness of this Code of Conduct in
197 achieving its aims.
- 198 b) Evaluate current and future developments that influence energy consumption, (i.e.,
199 Integrated Circuit development, etc.) with a view to agreeing actions and/or
200 amendments to the Code of Conduct.
- 201 c) Set targets for future time periods.

202 **5. REPORTING**

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

205 **A. GENERAL PRINCIPLES**

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

208 **A.1 For broadband equipment in general**

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

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

216 A.1.3 Signatories will endeavour to assist in the improvement of the existing low-power
217 standards, and the development of new ones as appropriate.²

218 **A.2 For CPE**

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

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

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

232 **A.3 For network equipment**

233 A.3.1 Broadband network equipment should be designed to fulfil the environmental
234 specifications of Class 3.1 for indoor use according to the ETSI Standard EN
235 300019-1-3 [5], and where appropriate the more extended environmental conditions
236 than Class 3.1 for use at outdoor sites. At remote sites the outdoor cabinet including
237 the Broadband network equipment shall fulfil Class 4.1 according to the ETSI
238 Standard EN 300019-1-4 [6]. Broadband network equipment in the outdoor cabinet
239 should be designed taking in account the characteristics of the cabinet and the
240 outdoor environmental condition; e.g., in case of free cooling cabinet it should be
241 considered that the equipment inside the cabinet could operate (for short time
242 periods) at temperature up to 60° C. If cooling is necessary, it should be preferably
243 cooled with fresh air (fan driven, no refrigeration). The Coefficient of Performance

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

244 of new site cooling systems, defined as the ratio of the effective required cooling
245 power to the energy needed for the cooling system, should be higher than 10.
246

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 or in case of ADSL2plus to the L2 mode). In case of dual WAN interface³, for backup or alternative purposes, only one of the two ports will be in the above described state, 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

³ 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.

Port / component	Idle-state
	ports will be in the above described state.
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).

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,

Port / component	Idle-state
	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.
Print server	No print job active.

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 recommended that copper Ethernet (IEEE 802.3 [11]) interfaces in the CPE comply with EEE. To allow sufficient time for equipment implementation, allowances for EEE capable Ethernet ports are defined and coexist with allowances for non-EEE capable ports. Starting January 1st 2016, there will be a single target based on the use of EEE implementations only. 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	Processing the user traffic present on the WAN and LAN interfaces.

Port / component	On-state
interface)	
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 above described state, 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 will be in the above described state.
ADSL2plus	Line is configured as per TR-100 [12], 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: 3 Mbit/s downstream, 0,3 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, 2 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: 20 Mbit/s downstream, 5 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 50 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	Link established at 100 Mbit/s and passing user traffic: 20 Mbit/s

Port / component	On-state
WAN	downstream, 5 Mbit/s upstream.
Fibre PtP Gigabit Ethernet WAN	Link established at 1000 Mbit/s and passing user traffic: 50 Mbit/s downstream, 10 Mbit/s upstream.
GPON	Passing user traffic: 10 Mbit/s downstream, 10 Mbit/s upstream.
1G-EPON	Passing user traffic: 10 Mbit/s downstream, 10 Mbit/s upstream.
10/1G-EPON	Passing user traffic: 50 Mbit/s downstream, 5 Mbit/s upstream.
10/10G-EPON	Passing user traffic: 50 Mbit/s downstream, 10 Mbit/s upstream.
XG-PON1	Passing user traffic: 50 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.
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 IEEE Low-Power Idle mode during testing (i. e., the interface will return to idle mode between each burst).
LAN Gigabit Ethernet ports	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 IEEE 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 5 Mbit/s downstream and 5 Mbit/s upstream (where simultaneous dual-band operation is supported, this

Port / component	On-state
	traffic is used).
Wi-Fi 802.11n or 11ac	Beacon on, 1 Wi-Fi 802.11n 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 (where simultaneous dual-band operation is supported, this traffic is used).
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).
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 $\leq 10\text{mW}$, RF power 10mW-50mW)	active, client 5m away in the same room, with user traffic: 2 Mbit/s.

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**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).

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

309 **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.

310 **B.2 Definitions of network operation states**

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

- 312
- 313 • Network (e.g., DSL)-stand-by state: This state has the largest power reduction
314 capability and there is no transmission of data possible. It is essential for this state that
315 the device has the capability to respond to an activation request, leading to a direct
316 state change. E.g., a transition to the network-full-load state may happen if data has to
be transmitted from either side.
 - 317 • Network (e.g., DSL)-low-load state: This state allows a limited power reduction
318 capability and a limited data transmission is allowed. It is entered automatically from
319 the network-full-load state after the data transmission during a certain time is lower
320 than a predefined limit. If more than the limited data has to be transmitted from either
321 side, a state change to the network-full-load state is entered automatically. The
322 network-low-load state may comprise multiple sub-states with history dependent state-
323 transition rules.
 - 324 • Network (e.g., DSL)-full-load state: This is the state in which a maximal allowed data
325 transmission is possible. The maximum is defined by the physical properties of the
326 line and the settings of the operator.
 - 327 • For the wireless network equipment also the following states are defined:
 - 328 o Busy hour-load-state
 - 329 o Medium-load-state
 - 330 o Low-load-state

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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 gateway⁴ 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 Wi-Fi 802.11n interfaces or Gigabit Ethernet LAN ports, i.e., to a Gigabit Ethernet interface a Gigabit Ethernet capable device must be connected for measurement purposes and the Gigabit Ethernet target applies. 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.

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. The targets must be met under two conditions (and only the highest value should 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

⁴ A home gateway is used here as a generic term which encompasses all kinds of access interfaces (e.g. DSL, cable, fibre, etc.)

- 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.

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

Home gateway central functions plus WAN interface	Tier 2013-2014: 1.1.2013 - 31.12.2014		Tier 2015-2016: 1.1.2015 - 31.12.2016	
	Idle- State (W)	On-State (W)	Idle- State (W)	On-State (W)
ADSL2plus	2,4	3,4	2,2	2,8
VDSL2 (8, 12a, 17a, but not 30a) Note 10.3	3,2	4,6	3,2	4,0
VDSL2 (30a) Note 10.3	4,7	5,3	4,3	4,8
Fast Ethernet WAN	2,0	3,0	1,5	2,0
Gigabit Ethernet WAN	2,5	5,0	2,5	4,5
Fibre PtP Fast Ethernet WAN	2,9	5,0	2,5	4,5
Fibre PtP Gigabit Ethernet WAN	3,2	5,6	2,6	4,8
GPON	3,5	5,0	3,2	4,0
1G-EPON	3,5	4,7	3,2	4,0
10/1G-EPON	4,8	6,2	Note 10.4 4,0	Note 10.4 5,0
10/10G-EPON	5,3	7,7	Note 10.4 4,5	Note 10.4 6,3
XG-PON1	4,8	6,5	Note 10.4 4,0	Note 10.4 5,2
DOCSIS 2.0	3,7	4,6	3,7	4,6
DOCSIS 3.0 basic configuration	6,2	7,1	5,2	6,2
DOCSIS 3.0 additional power allowance for each additional 4 downstream channels	2,2	2,8	2,0	2,5
WiMAX	3,5	6,0	2,8	4,8
3G	3,5	6,0	2,8	4,8
LTE	3,5	6,0	2,8	4,8

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 2013-2014: 1.1.2013 - 31.12.2014		Tier 2015-2016: 1.1.2015 - 31.12.2016	
	Idle-State (W)	On-State (W)	Idle-State (W)	On-State (W)
Fast Ethernet WAN	0,2	0,4	0,2	0,4
Gigabit Ethernet WAN	0,7	2,4	0,3	1,0
Fibre PtP Fast Ethernet WAN	1,1	2,4	1,1	2,4
Fibre PtP Gigabit Ethernet WAN	1,4	3,0	1,4	3,0
WiMAX	1,7	3,4	1,7	3,4
3G	1,7	3,4	1,7	3,4
LTE	1,7	3,4	1,7	3,4

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

Home gateway additional Backup WAN interface	Tier 2013-2014: 1.1.2013 - 31.12.2014		Tier 2015-2016: 1.1.2015 - 31.12.2016	
	Idle-State (W)	On-State (W)	Idle-State (W)	On-State (W)
ADSL2plus Note 10.5	2,4	1,0	0,9	1,0
VDSL2 (8, 12a, 17a, but not 30a) Note 10.5	3,2	2,2	1,6	2
VDSL2 (30a) Note 10.5	4,7	2,9	2,5	2,9
Fast Ethernet WAN	0,4	0,6	0,4	0,6
Gigabit Ethernet WAN	0,9	2,6	0,6	1,0
Fibre PtP Fast Ethernet WAN	1,3	2,6	1,3	2,6
Fibre PtP Gigabit Ethernet WAN	1,6	3,2	1,6	3,2

WiMAX	1,9	3,6	1,9	3,6
3G	1,9	3,6	1,9	3,6
LTE	1,9	3,6	1,9	3,6

Notes:

(10.5) In tier 2013/2014, On-State values for simultaneous ADSL and VDSL were set lower than Idle-State values. There is already enough On mode allowances in the WAN and Central functions and other LAN allowances to account for the product needs. In Tier 2015/2016, this situation is corrected.

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

Home gateway LAN interfaces and additional functionality	Tier 2013-2014: 1.1.2013 - 31.12.2014		Tier 2015-2016: 1.1.2015 - 31.12.2016	
	Idle-State (W)	On-State (W)	Idle-State (W)	On-State (W)
1 Fast Ethernet port	0,2	0,4	0,2	0,4
1 Fast Ethernet port supporting EEE	0,2	0,3	0,2	0,3
1 Gigabit Ethernet port	0,2	0,6	0,2	0,6
1 Gigabit Ethernet port supporting EEE	0,2	0,4	0,2	0,4
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	1,5	0,7	1,3
Wi-Fi interface, IEEE 802.11a/h radio with up to 30 dBm EIRP Note 11.1	0,7	2,5	0,7	2,2
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	2,0
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	3,0	0,8	2,5
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	1,2	2,9	1,0	2,5
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	2,1	3,4
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	2,1	3,8
Additional allowance per 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 RF chain above a 2x2 MIMO configuration (e.g., for 3x3 and 4x4) with up to 27 dBm EIRP per chain	0,1	1,6	0,1	1,5

Home gateway LAN interfaces and additional functionality	Tier 2013-2014: 1.1.2013 - 31.12.2014		Tier 2015-2016: 1.1.2015 - 31.12.2016	
	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)	0,5	0,5	0,4	0,4
POF (above 200 Mbit/s)	2,0	2,0	1,8	1,8
MoCA 1.1	1,8	2,2	1,7	2,1
MoCA 2.0	1,8	2,2	1,7	2,1
Powerline - High speed for broadband home networking (up to 30MHz bandwidth)	1,5	2,0	1,3	1,8
Powerline - High speed for broadband home networking (up to 68 MHz bandwidth)	2,0	2,7	2,0	2,7
Powerline - High speed for broadband home networking (up to 86 MHz bandwidth)	4,0	4,5	4,0	4,5
High speed powerline adapters (2xN up to 86 MHz bandwidth)	4,7	5,5	4,7	5,5
PowerLine - Low speed for smart metering and appliances control (Green Phy)	0,8	1,5	0,6	1,3
FXS	0,3	1,2	0,2	1,0
ISDN S0	0,2	0,4	0,2	0,3
FXO	0,2	0,9	0,2	0,7
Emergency fall-back to analog telephone per FXS	0,3	0,3	0,2	0,2
DECT GAP	0,5	1,0	0,5	0,9
DECT Cat-iq	0,5	1,2	0,5	1,0
DECT ULE	0,1	0,2	0,1	0,2
DECT charging station for DECT handset in slow/trickle charge	0,4	0	0,4	n.a.
USB 2.0 – no load connected	0,1	0,1	0,1	0,1
USB 3.0 – no load connected	0,15	0,15	0,1	0,1
SATA – no load connected	0,3	0,3	0,2	0,2
HDMI	0,3	0,3	0,2	0,2
Built-in back-up battery	0,1	0,1	0,1	0,1
Bluetooth	0,1	0,3	0,1	0,2
ZigBee	0,1	0,1	0,1	0,1
Z-Wave	0,1	0,2	0,1	0,1
IEC 14543-310 (“EnOcean”)	0,1	0,2	0,1	0,1

Home gateway LAN interfaces and additional functionality	Tier 2013-2014: 1.1.2013 - 31.12.2014		Tier 2015-2016: 1.1.2015 - 31.12.2016	
	Idle-State (W)	On-State (W)	Idle-State (W)	On-State (W)
Femtocell (Home use, RF power $\leq 10\text{mW}$)	6,0	7,0	4,5	5,5
Femtocell (Home use. RF power 10mW-50mW)	9,0	10,0	6,5	7,5
Integrated Storage (Flash e.g. eMMC, SSD or SD Card)	0,2	0,2	0,1	0,1
PCIe Interface (Connected)	0,2	0,2	0,2	0,2
RF modulator (TV overlay for fibre network)	3,2	3,2	3,0	3,0
Embedded hands-free system	0,5	0,5	0,3	0,5
Additional Colour Display with Display size defined by area A in (dm ²); (typically found in VoIP devices)				
$A \leq 0,10$	0,5	0,5	0,5	0,5
$0,10 < A \leq 0,30$		1,0		0,9
$0,30 < A \leq 0,50$		1,5		1,3
$0,50 < A \leq 0,70$		2,0		1,7
$0,70 < A \leq 1,00$		2,5		2,1
$1,00 < A \leq 1,40$		3,0		2,5
$1,40 < A \leq 1,80$		3,5		2,8
$1,80 < A \leq 2,20$		4,0		3,1
$2,20 < A \leq 2,80$		4,5		3,6

Notes:

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

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 2013-2014: 1.1.2013 - 31.12.2014		Tier 2015-2016: 1.1.2015 - 31.12.2016	
	<i>CPE-Idle-State (W)</i>	<i>CPE-On-State (W)</i>	<i>CPE-Idle-State (W)</i>	<i>CPE-On-State (W)</i>
DSL-modem powered by USB	1,5	1,5	1,5	1,5
GPON ONU with 1 Gigabit Ethernet LAN port	2,5	4,0	2,3	3,2
1G-EPON ONU with 1 Gigabit Ethernet LAN port	2,3	3,5	2,3	3,2
10/1G-EPON ONU with 1 Gigabit Ethernet LAN port	3,8	5,7	Note 12.4 3,6	Note 12.4 5,0
10/10G-EPON ONU with 1 Gigabit Ethernet LAN port	4,3	7,0	Note 12.4 4,1	Note 12.4 6,2
XG-PON1 ONU with 1 Gigabit Ethernet LAN port	3,8	6,0	Note 12.4 3,6	Note 12.4 5,4
Fast Ethernet PtPONU with 1 Fast Ethernet LAN port	2,8	2,8	2,6	2,6
Gigabit Ethernet PtPONU with 1 Gigabit Ethernet LAN port	3,2	3,2	3,0	3,0

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.

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 2013-2014: 1.1.2013 - 31.12.2014		Tier 2015-2016: 1.1.2015 - 31.12.2016	
	<i>Idle-State (W)</i>	<i>On-State (W)</i>	<i>Idle-State (W)</i>	<i>On-State (W)</i>
3G/4G	0,5	1,75	0,4	1,5
DECT	0,4	0,6	0,3	0,5
DECT GAP	0,4	1,3	0,3	1,1
DECT Cat-iq	0,4	0,6	0,3	0,5
DECT ULE	0,1	0,4	0,1	0,3
Wi-Fi interface single IEEE 802.11b/g or 1x1 IEEE 802.11n radio Note 13.1	0,8	2,0	0,6	1,7
ZigBee	0,1	0,4	0,1	0,3
Z-Wave	0,1	0,4	0,1	0,3
IEC 14543-310 (“EnOcean”)	0,1	0,4	0,1	0,3

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 2013-2014: 1.1.2013 - 31.12.2014		Tier 2015-2016: 1.1.2015 - 31.12.2016	
	<i>Idle- State (W)</i>	<i>On- State (W)</i>	<i>Idle- State (W)</i>	<i>On- State (W)</i>
Wi-Fi Access Points with IEEE 802.11b/g or 11a	2,2	3,4	2,0	3,0
Wi-Fi Access Points with IEEE 802.11n or 802.11ac radio with up to 20 dBm total EIRP at 2,4 GHz	2,3	3,9	2,1	3,3
Wi-Fi Access Points with IEEE 802.11n or 802.11ac radio with up to 23 dBm total EIRP at 5 GHz	3,6	5,3	3,6	5,3
Wi-Fi Access Points with IEEE 802.11n or 802.11ac radio with up to 30 dBm total EIRP at 5 GHz	3,6	5,7	3,6	5,7
Gigabit Ethernet optical LAN adapters (fiber converter or POF adapter)	3,2	3,2	2,8	2,8
Ethernet optical LAN adapters (fiber converter or POF adapter) up to 200 Mbit/s	1,5	1,5	1,3	1,3
MoCA LAN adapters	4,0	4,0	3,5	3,5

Power targets for Home Network Infrastructure Devices	Tier 2013-2014: 1.1.2013 - 31.12.2014		Tier 2015-2016: 1.1.2015 - 31.12.2016	
	<i>Idle- State (W)</i>	<i>On- State (W)</i>	<i>Idle- State (W)</i>	<i>On- State (W)</i>
DECT ULE LAN adapters	0,2	0,2	0,2	0,2
ZigBee LAN adapters	0,3	0,4	0,2	0,3
Z-Wave LAN adapters	0,3	0,4	0,3	0,3
IEC 14543-310 (“EnOcean”) LAN adapters	0,3	0,4	0,2	0,3
High speed powerline adapters (up to 30 MHz bandwidth)	3,0	4,0	2,5	3,5
High speed powerline adapters (up to 68 MHz bandwidth)	3,5	5,0	3,5	4,0
High speed powerline adapters (up to 86 MHz bandwidth)	4,3	4,5	4,3	4,5
High speed powerline adapters (2xN up to 86 MHz bandwidth)	5,0	5,5	5,0	5,5
PowerLine – low speed for smart metering and appliance control (Green Phy)	0,8	1,5	2,0	3,0
HPNA LAN adapter	3,5	4,0	3,2	3,6
Small hubs and non-managed 4 port Layer 2 Fast Ethernet switches without CPU (no VPN or VoIP)	1,4	2,0	1,3	1,8
Small hubs and non-managed 4 port Layer 2 Gigabit Ethernet switches without CPU (no VPN or VoIP)	1,5	2,8	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 2013-2014: 1.1.2013 - 31.12.2014		Tier 2015-2016: 1.1.2015 - 31.12.2016	
	Idle-State (W)	On-State (W)	Idle-State (W)	On-State (W)
ATA / VoIP gateway	1,3	2,1	1,3	2,1
VoIP telephone	2,7	3,5	2,7	3,5
VoIP telephone including Gigabit Ethernet Switching Function	3,9	4,3	3,9	4,3
Print server (without Wi-Fi)	1,8	3,6	1,8	3,6

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.

- All power values measured at the power interface port interface as described in the standard ETSI ES 203215 [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, will be increased by 10%. In case of integrated remote or reverse powered systems, the power limits stated may be increased by 15 %.
- The targets indicated as “Native ADSL2plus” apply for equipment that is designed to operate natively in ADSL2plus mode and not VDSL2 equipment operating in ADSL2plus fallback mode.
- Although no target is defined in this version of the broadband Code of Conduct for the energy consumption of VDSL2 equipment when operating in fallback mode, the actual consumption has to be tested and reported within the reporting sheet.
- 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.
- 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.
- 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 ES

203215 [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 network equipment

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

Power targets for DSL-full-load-state	Tier 2013-2014 (1.1.2013-31.12.2014) (W)	Tier 2015-2016 (1.1.2015-31.12.2016) (W)
Native ADSL2plus (including ADSL and ADSL2 and with transmission power of 19,8 dBm)	1,1	1,1
ADSL2plus fallback from VDSL2 (including ADSL2 and with transmission power of 19,8 dBm)	N/A	Note 16.1
ADSL2plus fallback from VDSL2 (including ADSL2 and with transmission power of 14,5 dBm)	N/A	Note 16.1
VDSL2 (profile 8b) transmission power 19,8 dBm	1,6	1,4
VDSL2 (profile 12a and 17a) transmission power 14,5 dBm	1,5	1,3
VDSL2 (profile 30a) transmission power 14,5 dBm	1,7	1,5
G.fast (106 MHz profile)	N/A	Note 16.1

Notes:

(16.1) This target should be defined in the next version of the CoC.

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) 0,3 W per line may be added to the above values, with a minimum value of 10 W for the whole DSLAM. Starting from 1.1.2015, the additional allowance is reduced to 0,15W per line with a minimum value of 5W. For ADSL the port threshold is set at 100.

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

Equipment	Tier 2014 (1.1.2014-31.12.2014) (W) - NOTE	Tier 2015-2016 (1.1.2015-31.12.2016) (W) – NOTE
Vectored VDSL2 (profile 12a and 17a with transmission power 14,5 dBm) without crosstalk cancelling among	+0,1	+0,05

boards		
Vectored VDSL2 (profile 12a and 17a with transmission power 14,5 dBm) with crosstalk cancelling among boards for up to 128 ports	+0,3	+0,2
Vectored VDSL2 (profile 12a and 17a with transmission power 14,5 dBm) with crosstalk cancelling among boards for more than 128 ports	+0,6	+0,5
Vectored VDSL2 (profile 30a with transmission power 14,5 dBm) without crosstalk cancelling among boards	+0,2	+0,1
Vectored VDSL2 (profile 30a with transmission power 14,5 dBm) with crosstalk cancelling among boards for up to 128 ports	+0,3	+0,25
Vectored VDSL2 (profile 30a with transmission power 14,5 dBm) with crosstalk cancelling among boards for more than 128 ports	+0,6	+0,5

494 **Notes:**

495 (16.2) Consumption limits are expressed as an additional allowance in [W/port] to be
496 applied to the corresponding consumption target for non-vectoring capable VDSL2
497 equipment (see Table 16).

498 The additional allowance for the uplink interface (applicable for all power states: full, low &
499 standby) is:

- 500 • 4,5 W per equipment for each PtP 1000Mbit/s interface
- 501 • 9,0 W per equipment for each PtP 10Gbit/s interface
- 502 • 6,0 W per equipment for each PON (GPON) interface
- 503 • 5,0 W per equipment for each PON (1G-EPON) interface
- 504 • 7,5 W per equipment for each PON (10/1G-EPON) interface
- 505 • 9,0 W per equipment for each PON (10/10G-EPON) interface

506 Starting from 1-1-2015, the additional allowance for the uplink interface (applicable for all
507 power states: full, low &standby) is:

- 508 • 2,0 W per equipment for each PtP 1000Mbit/s interface (*)
- 509 • 6,0 W per equipment for each PtP 10Gbit/s interface (*)
- 510 • 4,0 W per equipment for each PON (GPON) interface
- 511 • 2,0 W per equipment for each PON (1G-EPON) interface
- 512 • 5,0 W per equipment for each PON (10/1G-EPON) interface
- 513 • 6,0 W per equipment for each PON (10/10G-EPON) interface

514 (*) Energy Efficient Ethernet should be implemented

Table 17: Broadband ports – DSL-low-load-state | Note 17.1

Power targets for DSL-low-load-state	Tier 2013-2014 (1.1.2013-31.12.2014) (W)	Tier 2015-2016 (1.1.2015-31.12.2016) (W)
ADSL2plus (including ADSL2) (L2 state)	0,7	0,7
VDSL2 Note 17.2	N/A	N/A For further study, subject to definition of L2 state in ITU-T

Notes:

(17.1) The DSL-low-load-state should allow a bit rate of a configurable value (e.g. for keep-alive-signals, voice). The DSL-low power state levels shall not hamper the quality of service. In order to solve the issues caused by non-stationary cross talk, further investigations need to be done. They could be attenuated by the application of much longer time intervals between state transitions (15-30 minutes) than those defined today (1-255 seconds). This requirement comes into effect when the issues on the quality of service have been solved by the standardization bodies.

(17.2) The DSL-low-load-state is not foreseen today in the standard for VDSL2. Operators and manufacturers are urged, through their representatives in the standardization bodies, to make effort towards low power states with corresponding values, which are indicated here as targets for future standard revisions. This requirement comes into effect when relevant standards are available.

(17.3) Vectored VDSL2 targets are for further study.

Table 18: Broadband ports – DSL-standby-state (L3 State) | Note 18.1

Power targets for DSL-standby-state	Tier 2013-2014 (1.1.2013-31.12.2014) (W)	Tier 2015-2016 (1.1.2015-31.12.2016) (W)
ADSL2plus (including ADSL and ADSL2)	0,3	0,3
VDSL2	0,5	0,5

Notes:

(18.1) DSL-standby-state shall correspond to the L3 mode as defined in ITU-T Rec G.992,3 [19], ITU-T Rec G.992,5 [20] and ITU-T Rec G.993,2 [18]. A short start up time of < 1 second has to be realized to guarantee triple-play functions like VoIP and Video over IP (while the current value for this start up time is around 3 seconds). This requirement comes into effect when relevant standards are available.

(18.2) Vectoring doesn't apply to stand-by state

The DSL-low-load-state should allow a bit rate of a configurable value (e.g. for keep-alive-signals)

The above values for DSL-low-load 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) 0,3 W per line may be added to the above values for the whole DSLAM, with a minimum value of 10W. For ADSL the port threshold is set at 100.

Starting from 1.1.2015, the additional allowance is reduced to 0,15W per line with a minimum value of 5W

Start-up/Wake-up times from DSL-standby-state to DSL-full-power-state should be less than 1 second to guarantee a good quality of service (e.g., voice calls).

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-load 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 2013-2014 (1.1.2013-31.12.2014) (mW)	Tier 2015-2016 (1.1.2015-31.12.2016) (mW)
ADSL2plus (including ADSL2)	40	30
VDSL2	40	30

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 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 and POTS functions, the power consumption of these boards are to be measured separately for each function, i.e., measure Broadband 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 2013-2014				Tier 2015-2016			
	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 19.2, 19.3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3

Per-port MSAN POTS power consumption limits in Watt	Tier 2013-2014				Tier 2015-2016			
	PortState line feed (W)				PortState line feed (W)			
PortState	40mA	32mA	25mA	20mA	40mA	32mA	25mA	20mA
Provisioned for POTS - off-hook Note 19.2	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 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) 0,3 W per line may be added to the above values for the whole MSAN, with a minimum value of 10 W.

Starting from 1.1.2015, the additional allowance is reduced to 0,15W per line with a minimum value of 5W

It is further assumed that power consumed by MSAN functionality which is common to both Broadband 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 and POTS functions, the power consumption of these boards are to be measured separately for each function, i.e., measure Broadband 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.

The additional allowance for the uplink interface is:

- 4,5 W per equipment for each PtP 1000Mbit/s interface
- 9,0 W per equipment for each PtP 10Gbit/s interface
- 6,0 W per equipment for each PON (GPON) interface
- 5,0 W per equipment for each PON (1G-EPON) interface
- 7,5 W per equipment for each PON (10/1G-EPON) interface
- 9,0 W per equipment for each PON (10/10G-EPON) interface

Starting from 1-1-2015, the additional allowance for the uplink interface (applicable for all power states: full, low & standby) is:

- 2,0 W per equipment for each PtP 1000Mbit/s interface (*)
- 6,0 W per equipment for each PtP 10Gbit/s interface (*)
- 4,0 W per equipment for each PON (GPON) interface
- 2,0 W per equipment for each PON (1G-EPON) interface

- 604 • 5,0 W per equipment for each PON (10/1G-EPON) interface
- 605 • 6,0 W per equipment for each PON (10/10G-EPON) interface
- 606 (*) Energy Efficient Ethernet should be implemented
- 607 **C.2.3 Optical Line Terminations (OLT) for PON and Pt Pnetworks**

Table 20: Optical Line Terminations for PON ports

	<= 32 PON ports			> 32 PON ports		
Power targets for Optical Line Terminations for PON ports	Tier 2013 (1.1.2013) (W)	Tier 2014 (1.1.2014) (W)	Tier 2015 - 2016 (1.1.2015)- (31.12.2016) (W)	Tier 2013 (1.1.2013) (W)	Tier 2014 (1.1.2014) (W)	Tier 2015 - 2016 (1.1.2015)- (31.12.2016) (W)
GPON (2.5G/1G)						
OLT (GPON, fully equipped with maximum configuration implementing standard Layer-2 (Ethernet) aggregation functionalities, including Multicast)	8,8	8,1	6,0	8,3	7,7	5,6
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)	9,3	8,5	6,5	8,7	8,0	6,0
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	15,0	15,0	13,0	13,0	13,0
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	18,0	18,0	15,0	15,0	15,0
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	5,0	5,0	5,0	5,0	5,0
EPON (1G/1G)						

	<= 32 PON ports			> 32 PON ports		
Power targets for Optical Line Terminations for PON ports	Tier 2013 (1.1.2013) (W)	Tier 2014 (1.1.2014) (W)	Tier 2015 - 2016 (1.1.2015)- (31.12.2016) (W)	Tier 2013 (1.1.2013) (W)	Tier 2014 (1.1.2014) (W)	Tier 2015 - 2016 (1.1.2015)- (31.12.2016) (W)
OLT (1G-EPON, fully equipped with maximum configuration implementing standard Layer-2 (Ethernet) aggregation functionalities, including Multicast)	8,1	8,1	5,9	7,7	7,7	5,5
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)	8,8	8,8	6,4	8,1	8,1	6,0
10G/1G EPON Note 20.1						
OLT (10/1G-EPON, fully equipped with maximum configuration implementing standard Layer-2 (Ethernet) aggregation functionalities, including Multicast)	18,3	17,5	15,5	15,3	14,6	12,6
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)	19,3	18,8	16,8	15,9	15,4	13,4
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	7,0	7,0	5,0	7,0	7,0	5,0
10G/10G EPON Note 20.1						
OLT (10/10G-EPON, fully equipped with maximum configuration implementing standard Layer-2 (Ethernet) aggregation functionalities, including Multicast)	19,5	18,8	16,6	16,9	16,2	14,0

	<= 32 PON ports			> 32 PON ports		
Power targets for Optical Line Terminations for PON ports	Tier 2013 (1.1.2013) (W)	Tier 2014 (1.1.2014) (W)	Tier 2015 - 2016 (1.1.2015)- (31.12.2016) (W)	Tier 2013 (1.1.2013) (W)	Tier 2014 (1.1.2014) (W)	Tier 2015 - 2016 (1.1.2015)- (31.12.2016) (W)
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)	20,5	20,0	17,8	17,4	16,7	14,5
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	7,0	7,0	5,0	7,0	7,0	5,0

Notes:

(20.1) 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 21: Optical Line Terminations for PtP ports

Power targets for Optical Line Terminations for PtP ports	Tier 2013-2014 (1.1.2013) (W)	Tier 2015-2016 (1.1.2015) (W)
PtP 1000Mbps		
OLT (PtP up to 1000 Mbit/s, up to 100 ports, fully equipped with maximum configuration)	4	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 12 ports, fully equipped with maximum configuration)	28	18
OLT (PtP at 10 Gbit/s, from 12 to 42 ports, fully equipped with maximum configuration)	20	13
OLT (PtP at 10 Gbit/s, with more than 42 ports, fully equipped with maximum configuration)	13	8

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

616 The additional allowance for the uplink interface is:

- 617 • 4,5 W per equipment for each PtP 1000Mbit/s interface
- 618 • 9,0 W per equipment for each PtP 10Gbit/s interface
- 619 • 6,0 W per equipment for each PON (GPON) interface
- 620 • 5,0 W per equipment for each PON (1G-EPON) interface
- 621 • 7,5 W per equipment for each PON (10/1G-EPON) interface
- 622 • 9,0 W per equipment for each PON (10/10G-EPON) interface

623 Starting from 1-1-2015, the additional allowance for the uplink interface (applicable for all
624 power states: full, low &standby) is:

- 625 • 2,0 W per equipment for each PtP 1000Mbit/s interface (*)
- 626 • 6,0 W per equipment for each PtP 10Gbit/s interface (*)
- 627 • 4,0 W per equipment for each PON (GPON) interface
- 628 • 2,0 W per equipment for each PON (1G-EPON) interface
- 629 • 5,0 W per equipment for each PON (10/1G-EPON) interface

630 • 6,0 W per equipment for each PON (10/10G-EPON) interface

631 (*) Energy Efficient Ethernet should be implemented

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

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

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

643 C.2.4 Wireless Broadband network equipment

644 **Table 22: Wi-Fi network equipment**

Power targets for Wi-Fi network equipment	Tier 2013-2014 (1.1.2013) (W)	Tier 2015-2016 (1.1.2015) (W)
Wi-Fi access points (Hotspot application) 802.11b/g/n or 802.11b/g/a – ON state and Active Standby Note 22.1	8	8

645 Notes:

646 (22.1) The On-state is defined with no traffic on the Wi-Fi port. Therefore there is no
647 difference in power consumption between the On-state and the Low-load-state
648 (Active Standby) for this equipment.

649 **Table 23: WiMAX network equipment**

Power targets for WiMAX network equipment	Tier 2013-2014 (1.1.2013) (W)		Tier 2015-2016 (1.1.2015) (W)	
	2,5 GHz	3,5 GHz	2,5 GHz	3,5 GHz
WiMAX Radio Base Station (3 sectors) – Busy-hour-load-state	560	530	510	480
WiMAX Radio Base Station (3 sectors) – Medium-load-state	480	460	440	420
WiMAX Radio Base Station (3 sectors) – Low-load-state	390	370	355	340

650 Configuration of WiMAX Radio Base Station:

651 1) 3 sectors, 2,5 GHz/3,5 GHz, 10 MHz bandwidth channel, 4 × 4 MIMO, 29:18 DL/UL
652 subframe ratio

653 2) Output power: 28 W (7 W × 4) (3,5 GHz) / 40 W (10 W × 4) (2,5 GHz) at antenna
654 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 2013-2014 (1.1.2013) (W)	Tier 2015-2016 (1.1.2015) (W)
	0,9/1,8/1,9 GHz	0,9/1,8/1,9 GHz
GSM/EDGE Radio Base Station (3 sectors) – Busy-hour-load-state	800	760
GSM/EDGE Radio Base Station (3 sectors) – Medium-load-state	700	650
GSM/EDGE Radio Base Station (3 sectors) – Low-load-state	580	540

1) Three sectors, four carriers per sector (S444)

2) Output power: 20 W at antenna interface for each carrier (4×20 W for each sector). For equipment that, differently from Remote Radio Units, are designed to be installed in shelters and will face feeder loss, the output power will have to be incremented by the feeder loss. For the table above, that loss is defined to be 3dB.

For GSM/EDGE Radio base station the busy hour load, medium load and low load states defined in ETSI TS 102 706 [10] shall be used.

Table 25: WCDMA/HSDPA network equipment

Power targets for WCDMA/HSDPA network equipment	Tier 2013-2014 (1.1.2013) (W)	Tier 2015-2016 (1.1.2015) (W)
	2,1 GHz	2,1 GHz
WCDMA/HSDPA Radio Base Station (3 sectors) – Busy-hour-load-state	800	760
WCDMA/HSDPA Radio Base Station (3 sectors) – Medium-load-state	670	650
WCDMA/HSDPA Radio Base Station (3 sectors) – Low-load-state	570	540

3 sectors, two carrier per sector (S222), Distributed Radio Base station with dual-TX Radio Remote Unit which nominal output power is less than 80W.

1) Output power: Output power: 20 W at antenna interface for each radio cell. (20 W+ 20 W for each sector). For equipment that, differently from Remote Radio Units, are designed to be installed in shelters and will face feeder loss, the output power will

have to be incremented by the feeder loss. For the table above, that loss is defined to be 3dB

For WCDMA/HSDPA Radio base station the states are differentiated (the state definitions are based on defined in ETSI TS 102 706 [10]) shall be used.

Table 26: Wireless broadband network equipment – LTE

Power targets for LTE wireless broadband network equipment	Tier 2013-2014 (1.1.2013) (W)	Tier 2015-2016 (1.1.2015) (W)
LTE Radio Base Station (3 sectors) – Busy-hour-load-state	900	840
LTE Radio Base Station (3 sectors) – Medium-load-state	750	700
LTE Radio Base Station (3 sectors) – Low-load-state	650	600

Configuration of LTE Radio Base Station:

- 1) 3 sectors, 2,6 GHz, 20 MHz bandwidth channel 2×2 MIMO
- 2) Output power: 40 W ($20 \text{ W} \times 2$) at antenna interface for each sector. For equipment that, differently from Remote Radio Units, are designed to be installed in shelters and will face feeder loss, the output power will have to be incremented by the feeder loss. For the table above, that loss is defined to be 3dB

For LTE Radio base station the following states are differentiated (the state definitions are based on draft ETSI TS 102 706 [10]):

Busy-hour and Medium-load-state: All REs dedicated to CCHs, reference and synchronisation signals shall be transmitted. In addition a certain number of PRBs dedicated to PDSCH shall be trans-mitted. The number of transmitted PRBs dedicated to PDSCH shall be calculated as such, that the complete power over the baseband bandwidth (20 MHz) and averaged over one LTE FDD frame (10 ms) is 50% (busy-hour-load) and 30% (medium-load) of the maximum rated power of the cell

Low-load-state: all REs dedicated to CCHs, reference and synchronization signals shall be transmitted

C.2.5 Cable network equipment

Cable network system vendors are developing new architectures, which incorporate multiple headend functionalities into a single piece of equipment. As these system designs develop, suitable power targets will be developed and included in the Code of Conduct. The industry expects to have estimates for these power targets in 2014. Deployment of these systems under development is expected to replace I-CMTS and M-CMTS equipment in the next several years, therefore investment in future power efficiency enhancements to current CMTS technology is not expected.

The power targets in this section apply to I-CMTS and M-CMTS equipment.

Table 27 CMTS Definitions

I-CMTS	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	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).

Table 28: Cable network equipment

Power targets for cable network equipment	Tier 2012-2014 (1.1.2012-31.12.2014) (W/Channel)	Tier 2015-2016 (1.1.2015-31.12.2016) (W/Channel)
I-CMTS	6	6
M-CMTS <u>Core</u>	6	6
Edge-QAM	3	3

709 An allowance of 4,5 W is provided for each Ethernet Point-to-Point 1 Gbit/s interface for M-
710 CMTS Core and Edge-QAM. An allowance of 8 W is provided for each M-CMTS Ethernet
711 Point-to-Point 10 Gbit/s interface for M-CMTS core and Edge-QAM.

712 The above values are nominal at 25° C per downstream channel (or QAM) for a fully
713 equipped chassis at its maximum configuration. Sparing features are not assumed. The
714 assumed configuration for I-CMTS and M-CMTS Core includes a ratio of two upstream
715 Service Groups paired with one downstream Service Group. It is assumed that the ratio of
716 number of channels in an upstream Service Group to number of channels in a downstream

717 Service Group is 1:4. For Edge-QAM, the assumed configuration is that all QAM channels
718 are configured as DOCSIS downstream channels. These power numbers reflect the total
719 chassis power divided by the number of downstream channels.

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

722 **C.2.6 Powerline network equipment**

723 Access powerline networks have not reached a high importance in Europe yet. When
724 powerline networks are developed, additional power targets for power line access equipment
725 should be included in this Code of Conduct.

726

728 D. EXAMPLE HOME GATEWAY POWER CONSUMPTION TARGETS

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

734 D.1 ADSL Home Gateway

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

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

Function	idle-state		on-state	
	2013/2014	2015/2016	2013/2014	2015/2016
Central functions + ADSL WAN interface	2,4	2,2	3,4	2,8
4 Fast Ethernet LAN ports	$4 \times 0,2 = 0,8$	$4 \times 0,2 = 0,8$	$4 \times 0,4 = 1,6$	$4 \times 0,4 = 1,6$
single radio IEEE 802.11b/g Wi-Fi interface (23 dBm EIRP)	0,7	0,7	1,5	1,3
USB 2.0 ports	$2 \times 0,1 = 0,2$	$2 \times 0,1 = 0,2$	$2 \times 0,1 = 0,2$	$2 \times 0,1 = 0,2$
Total equipment	4,1W	3,9W	6,7W	5,9W

739 D.2 VDSL2 Home Gateway

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

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

Function	idle-state		on-state	
	2013/2014	2015/2016	2013/2014	2015/2016
Central functions + VDSL2 WAN interface (17a)	3,2	3,2	4,6	4,0
4 Gigabit Ethernet LAN ports	$4 \times 0,2 = 0,8$	$4 \times 0,2 = 0,8$	$4 \times 0,6 = 2,4$	$4 \times 0,6 = 2,4$
single IEEE 802.11n radio Wi-Fi interface with 3 RF chains 3x3 MIMO (23 dBm)	$0,8+0,1 = 0,9$	$0,8+0,1 = 0,9$	$2,0+0,4 = 2,4$	$2,0+0,4 = 2,4$
USB 2.0 ports	$2 \times 0,1 = 0,2$	$2 \times 0,1 = 0,2$	$2 \times 0,1 = 0,2$	$2 \times 0,1 = 0,2$
FXS ports	$2 \times 0,3 = 0,6$	$2 \times 0,2 = 0,4$	$1,2+0,3 = 1,5$	$1,2+0,3 = 1,5$

Function	idle-state		on-state	
	2013/2014	2015/2016	2013/2014	2015/2016
Total equipment	5,7W	5,5W	11,1W	10,5W

747 **D.3 Ethernet router with 4 Fast Ethernet LAN ports**

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

749 - in idle-state: all Ethernet LAN ports disconnected

750 - in on-state: all Ethernet LAN ports active

Function	idle-state		on-state	
	2013/2014	2015/2016	2013/2014	2015/2016
Central functions + Fast Ethernet WAN interface	2,0	1,5	3,0	2,0
4 Fast Ethernet LAN ports	$4 \times 0,2 = 0,8$	$4 \times 0,2 = 0,8$	$4 \times 0,4 = 1,6$	$4 \times 0,4 = 1,6$
Total equipment	2,8W	2,3W	4,6W	3,6W

751 **D.4 Cable DOCSIS 3.0 CPE**

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

753 - in idle-state: the Ethernet LAN port is disconnected

754 - in on-state: the Ethernet LAN port is active

Function	idle-state		on-state	
	2013/2014	2015/2016	2013/2014	2015/2016
Central functions + DOCSIS 3.0 basic configuration WAN interface	6,2	5,2	7,1	6,2
1 DOCSIS 3.0 Additional power allowance for the additional 4 downstream channels	2,2	2,0	2,8	2,5
1 Gigabit Ethernet LAN port	0,2	0,2	0,6	0,6
Total equipment	8,6W	7,4W	10,5W	9,3W

755 **Complex HNID: dual-band 11n access point with 4 Gigabit Ethernet LAN ports**

Function	idle-state		on-state	
	2013/2014	2015/2016	2013/2014	2015/2016
Wi-Fi Access Points with single band IEEE 802.11n radio (23 dBm), 2x2 MIMO	2,3	2,1	3,9	3,3
single IEEE 802.11n radio Wi-Fi interface (23 dBm), 2x2 MIMO	0,8	0,8	2,0	2,0
3 additional Gigabit Ethernet LAN ports	$3 \times 0,2 = 0,6$	$3 \times 0,2 = 0,6$	$3 \times 0,6 = 1,8$	$3 \times 0,6 = 1,8$

Function	idle-state		on-state	
	2013/2014	2015/2016	2013/2014	2015/2016
Total equipment	3,7W	3,5W	7,7W	7,1W

756

757 **E. REPORTING FORM**

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

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

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

764

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 C.2.1, C.2.2 and C.2.3 shall comply with the Technical Specification ETSI ES 203 215 [16]. The method of power measurement for equipment in line with point C.2.4 shall comply with the Technical Specification ETSI TS 102 706 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 such systems, the power limits stated in Table 16 through Table 28 may be increased by 10%. In case of integrated remote or reverse powered systems, the power limits stated may be increased by 15 %.

The power limits have to be fulfilled for the system operating at ambient temperature ($25 \pm 2^\circ$ C). Fans, if present in network equipment in line with points C.2.1 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 synthesizing and at correctly exposing power management capabilities and corresponding consumption variation.

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

842 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
CoC	Code of Conduct
COP	Coefficient Of Performance
CPE	Customer Premises Equipment
DECT	Digital Enhanced Cordless Telecommunications
DOCSIS	Data Over Cable Service Interface Specification
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 Data rate 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 2 nd 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

843

I. LIST OF REFERENCES

- [1] ITU-T recommendation I.113, "Vocabulary of terms for broadband aspects of ISDN"
- [2] Code of Conduct for Digital TV Services (version 9 – 01.07.2013),
http://iet.jrc.ec.europa.eu/energyefficiency/sites/energyefficiency/files/code_of_conduct_digital_tv_service_systems_v9_final.pdf
- [3] Reporting sheet CoC BB equipment, <http://iet.jrc.ec.europa.eu/energyefficiency/ict-codes-conduct/energy-consumption-broadband-communication-equipment>
- [4] EU Code of Conduct for External Power Supplies (version 5 – 31.10.2013),
<http://iet.jrc.ec.europa.eu/energyefficiency/ict-codes-conduct/efficiency-external-power-supplies>
- [5] ETSI Standard EN 300019-1-3 European Standard, Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weather protected locations
- [6] ETSI Standard EN 300019-1-4 European Standard, Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-4: Classification of environmental conditions; Stationary use at non-weather protected locations
- [7] EU Code of Conduct on Energy Efficiency of Broadband Equipment, Version 4, 10th of February 2011
- [8] ETSI EN 300 132-2 European Standard, Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc)
- [9] COMMISSION REGULATION (EC) No 1275/2008 of 17 December 2008 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment
- [10] ETSI TS 102 706 V1.2.1, "Technical Specification, Environmental Engineering (EE), Energy Efficiency of Wireless Access Network Equipment"
- [11] IEEE Std 802.3™-2012, IEEE Standard for Ethernet
- [12] IEEE P802.3bk, draft D2.0, Draft Standard for Ethernet, Amendment 2: Physical Layer Specifications and Management Parameters for Extended Ethernet Passive Optical Networks
- [13] Broadband Forum TR-100 Issue 2 (August 2012), ADSL2/ADSL2plus Performance Test Plan, http://www.broadband-forum.org/technical/download/TR-100_Issue-2.pdf
- [14] Broadband Forum TR-114 Issue 2 (November 2012), VDSL2 Performance Test Plan, http://www.broadband-forum.org/technical/download/TR-114_Issue-2.pdf
- [15] ITU-T Recommendation G.984, "Gigabit-capable passive optical networks (GPON): General characteristics"
- [16] ETSI ES 203 215 V1.2.1, "ETSI Standard, Environmental Engineering (EE); Measurement Methods and Limits for Power Consumption in Broadband Telecommunication Networks Equipment"

- 886 [17] ITU-T Recommendation G.993.5, “Self-FEXT cancellation (vectoring) for use with
887 VDSL2 transceivers”
- 888 [18] ITU-T Recommendation G.993.2, “Very high speed digital subscriber line transceivers
889 2 (VDSL2)”
- 890 [19] ITU-T Recommendation G.992.3, “Asymmetric digital subscriber line transceivers 2
891 (ADSL2)”
- 892 [20] ITU-T Recommendation G.992.5, “Asymmetric digital subscriber line 2 transceivers
893 (ADSL2)– Extended bandwidth ADSL2 (ADSL2plus)”
- 894

895 J. SIGNING FORM

896 Code of Conduct
897 On Energy Consumption of Broadband Equipment

898 SIGNING FORM

899 The organisation/company/
900
901 signs the Code of Conduct on Energy Consumption of Broadband
902 Equipment and commits itself to abide to the principles described in point 3
903 “Commitment” for the equipment it produces, buys, installs or specifies.

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

907 for the organisation

908 Director or person authorised to sign:
909 Name:
910 Managerial Function:
911 Address:
912 Tel. / Fax:
913 Email:
914 Date:

915 Signature

916 Please send the signed form to:

917 Paolo Bertoldi
918 European Commission - DG JRC
919 TP 450
920 I-21027 Ispra (VA)
921 Tel. +39 0332 78 9299
922 Fax +39 0332 78 9992
923 E-mail: paolo.bertoldi@ec.europa.eu