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HGI-RD015-R3
Energy Efficiency and Ecodesign requirements for a common
power supply (CPS) for home gateway, home networking
equipment and end devices

April 29, 2010

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29

1 **2 Acronyms**

2	ADSL	Asymmetric Digital Subscriber Line
3	BSP	Broadband Service Provider
4	CPE	Customer Premises Equipment
5	CPS	Common Power Supply
6	DSL	Digital Subscriber Line
7	ETH	Ethernet
8	HG	Home Gateway
9	HGI	Home Gateway Initiative
10	HN	Home Network
11	NT	Network Termination
12		

3 Introduction

This document describes requirements for a common power supply (CPS) and is part of HGI's Release 3 specification family. It has been produced by the Energy Efficiency Task Force (ENG) and Technical Working Group (TWG) of the Home Gateway Initiative (HGI). It is the result of collaborative effort of HGI members that include Broadband Service Providers (BSPs), gateway manufacturers, and silicon vendors.

The CPS project is one of several HGI Release 3 activities addressing energy efficiency and "ecodesign". At a broader level the need for standardization activities in energy efficiency and ecodesign related to telecommunications is now widely seen. For example the European Union, in the "ICT 2009 Standardization Work Programme" highlights this need. Enabling the use of "standardized" power supplies, or the development of a new Common Power Supply (CPS) for DSL modems, home gateways, optical network terminations is a key aspect of telecommunications standardization that will contribute to ecodesign

Although this document stands on it own, it is probable that it will be proposed as input to standardization bodies such as ETSI, ITU-T or CENELEC.

The potential timeline envisaged by the HGI Management Committee for adoption of this CPS specification is as follows:

- Initial, partial deployments prior to 2011
- Universal deployments for all home gateways deployed within certain service providers' networks (i.e. within those service providers mandating this requirement) starting from 2011

3.1 Scope and purpose of this document

This document defines a universal solution for power supplies (named Common Power Supply and indicated with the acronym CPS) suitable for equipment used in the home networks. The topics addressed in the document are as follows:

- Applicability: definition of product categories included in the scope (home gateway, and various other possible devices installed in the home network)
- Market scenarios and use cases description for the re-usage of the CPS in the home environment (usage with different categories of devices, reuse in case of substitution with the same category of device)
- Requirements for electrical operating conditions of the CPS
- Requirements for energy efficiency of the CPS
- Requirements for connectors on the CPS and devices which it powers
- Requirements for eco-design of the CPS

3.2 Definitions of terms

The definitions of MUST and SHOULD in this document are therefore as follows:

MUST	A functional requirement which is based on a clear consensus among HGI Service Provider members, and is the base level of required functionality for a given class of equipment.
MUST NOT	This function is prohibited by the specification.
SHOULD	Functionality which goes beyond the base requirements for a given class of equipment, and can be used to provide vendor product differentiation (within that class).

Note: These definitions are specific to the HGI and should not be confused with the same or similar terms used by other bodies.

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2

1 **4 Applicability**

2 **4.1 Home Gateway Power Supply**

3 Home gateways currently use external power supplies (“bricks”) that provide different ranges of
4 output voltage and current.

5 Furthermore, the connectors on the HG which attach to the power supply, and the corresponding
6 connectors on the cable frequently differ, not only between HGs of different vendors, but also between
7 different HG models from the same vendor. A suitable output voltage and current, along with connector
8 type would have to be specified to create a truly “universal” solution applicable to all home gateways.

9 **4.2 HNID Power Supply**

10 In addition to home gateways, other home network infrastructure devices (HNIDs) may use a power
11 supply with similar features in terms of voltage and current, so that a common solution could be defined for
12 both types of device.

13 These HNID devices may have a similar specification and distribution process, in other words they
14 are managed and/or supplied by a common BSP. Therefore, the extension of the CPS solution defined for
15 HGs to HNIDs has also been considered.

16 **4.3 End Device Power Supply**

17 Some end user devices use power supplies with similar characteristics to those of HGs (e.g. some
18 set top boxes, cordless phones and IP phones).

19 The requirements contained in this document apply to all the above mentioned categories.

1 **5 Market scenarios and use cases**

2 **5.1 The state of the art**

3 **5.1.1 Market situation**

4 A number of different categories of devices will already be present in the home environment or can
5 be installed as part of the service offering proposed by the single service provider; all of them needing an
6 external power supply. There can be:

- 7 • Home gateways
- 8 • Set top boxes
- 9 • Fixed IP telephones or analogue phones with specific features such as displays
- 10 • Fixed cordless telephones
- 11 • PDAs/tablet PCs/smart terminals devoted to specific service usage
- 12 • HNIDs such as bridges between different technologies, hubs and switches, wireless repeaters or
13 additional (to the HG one) access points

14 An analysis of commonly deployed power supplies shows that there are two basic categories of
15 power supplies adopted, with relatively small differences in output voltage and current across a wide
16 number of device examples:

- 17 • Lower voltage power supplies
 - 18 ○ commonly, these devices have a fixed output voltage between 3,3 and 6 V (in some rare
19 cases 7,5 V) and a maximum output current below 0,5 A (typically, when a battery is to be
20 charged on the product)
 - 21 ○ as above, but with maximum output current between 1 A and 2 A
- 22 • Higher voltage power supplies
 - 23 ○ commonly, these power supplies have a fixed output voltage between 12 and 15 V and a
24 maximum output current below 0,5 A (typically, when a battery is to be charged on the
25 product)
 - 26 ○ as above, but with maximum output current between 1 and 2 A..

27 There are a large number of different power supplies on the market but with small differences in the
28 output current and voltage. A pre-analysis performed by Telecom Italia labs considered a total of 33
29 devices, all included in the two listed categories, all of which turned out to have a unique power supply.

30 In regard to choice of materials, current devices typically do not meet ecodesign best practice in the
31 following aspects:

- 32 • PVC is commonly used for cable construction. Alternatives with lower environmental impact
33 are possible.
- 34 • recycled plastics are not commonly used
- 35 • lack of design features allowing easily disassembling the product at the end of its life in
36 order to separate electronics from plastic parts.

37 **5.1.2 Power supply energy efficiency issues**

38 The following observations about energy efficiency with currently deployed devices can be made:

- 39 • switching power supplies achieve much better efficiencies than supplies based upon linear
40 technologies. For example for 24 V outputs, a switch-mode supply normally operates at 80%
41 or higher efficiency, whereas a linear power supply will typically operate around 60%

- 1 efficiency. Switching power supplies also achieve greater constancy of output voltage as
 2 current varies
- 3 • a typical switching power supply is able to achieve efficiency close to its maximum efficiency
 4 when it's operating at output currents lower than 20% of the maximum rated output current.
 5 Such a characteristic facilitates use of a common power supply for a wider range of load
 6 devices while still maintaining efficiency

7 The energy efficiency requirements must be aligned with the European Commission Regulations
 8 (EC) no. 278/2009 on External Power Supplies (implementing "EuP" Directive 2005/32/EC on ecodesign
 9 requirements for no-load condition electric power consumption and average active efficiency of external
 10 power supplies), or with the Energy Star requirements applicable to US market [2], [3].

11 5.2 CPS categories

12 The definition of a common power supply should consider existing digital home equipment, in order
 13 to ensure compatibility (where possible and appropriate) with existing devices. However the main focus of
 14 this work is to find a solution that will be widely adopted in the future. It did not prove practical to have a
 15 single CPS for all device types; this would have resulted in all PSUs being high power. The minimum
 16 realistic set is 2 Types, the Type being determined by the Output Voltage, with one of the 2 Types having 2
 17 subcategories (based on current and power). These variants are defined in Table 1. This should address
 18 the needs of all the home network device types described in this document:

19
20 Table 1 CPS categories

Category	Nameplate Output voltage	Nameplate Output Current	Rated Power	Output
TYPE 1	5 V	2 A	10 W	
TYPE 2 subcategory 1 (TYPE 2-1)	12 V	2 A	24 W	
TYPE 2 subcategory 2 (TYPE 2-2)	12 V	5 A	60 W	

22
23 Notes:

- 24 • Type 1 covers the needs of efficient equipment with low power consumption starting from
 25 2W. This includes covering the typical cordless phones with a battery that usually needs
 26 between 2 and 3 W during the charging phase, and some HNIDs. It will also provide good
 27 efficiency at lower load currents (e.g. after charging has completed).
- 28 • Type 2-1 is suitable for home gateways as is it covers the typical power needs of a HG
 29 designed to support the HGI Residential Profile v1.0 for the mandatory functionalities. Also,
 30 its adoption can be envisaged for set top boxes.
- 31 • Type 2-2 is designed for home networking equipment with higher energy consumption
 32 resulting from integration a wide range of functionalities (NAS, multimedia equipment, game
 33 consoles etc.)

34 5.2.1 Connectors

35 The connectors must be specified to handle the output voltage and current provided. However over
 36 and above this:

- 1 1. Type 2-2 connector on CPS side must not fit in a Type 2-1 connector on the load device
2 side, to avoid damaging the load equipment;
- 3 2. Type 1 and Type 2-1 connectors on the CPS side must not fit in a Type 2-2 connector on
4 the load device side: this would result in the CPS delivering less power than needed to the load device,
5 which would result in support calls.

6 **5.2.2 Reliability and environmental conditions**

7 CPS reliability must be consistent with the expected MTBFs and useful lives of the products they will
8 supply. Note that since one of the main points of a CPS is to allow its reuse with different generations of
9 CPE, it may need to last longer than current power supplies. MTBF is usually given in units of hours. The
10 failure rate is equal to failures/time [12], so MTBF is related to the yearly acceptable (for the service
11 provider or the vendor) number of failures¹. For example a MTBF of 100000 hours will correspond to a
12 yearly percentage of failures of around 8,7%.

13 All CPS types must guarantee normal operation under the same environmental conditions as the
14 powered device.

15

16 **5.3 The usage scenarios**

17 The following use cases concerning the use of a CPS on different devices must be supported:

18 **USE CASE 1**

19 A specific device using a CPS is discarded at the end of its useful life, or when the BSP decides to
20 upgrade to a new generation of device, or due to a failure. The replacement device can use the same
21 CPS and so avoid the need for the production and supply of a new power unit.

22 **USE CASE 2**

23 When a device using a CPS is dispensed with, that CPS can be kept by the user as a spare for
24 subsequent reuse e.g. in the event of failure of another CPS.

25 **USE CASE 3**

26 A new device which uses a CPS is bought by the user. If a suitable CPS is already owned, the product
27 can be purchased without a power supply. This Use Case requires a labelling scheme (out of the scope
28 of this document) to allow the user to understand which CPS could be reused with the new device.
29 Note however that if the device is supplied by the BSP, there will need to be a new process to
30 determine whether or not the user already has a suitable, spare CPS, and the ability to supply one, or
31 not, as appropriate. This has implications for packaging and installation guides etc. If the device is
32 provided via a retail outlet, then there needs to be a variant with and without a CPS, or the CPS will
33 need to be sold separately.

34 **USE CASE 4**

35 Some battery powered devices can share a CPS charger (e.g. mobile phones)

36

37 **5.4 Usability issues and CPS elements**

38 In general, the typical power supply for home networking equipment consists of a cable and the power
39 supply block containing an AC/DC converter and other electronics. This block includes on its primary side
40 the AC plug for connection to the wall socket (or other intermediate connections):

41

¹ MTBF = 1/failure rate, where failure rate = failures / time. Thus MTBF = time / failures and failures = time / MTBF. To calculate the yearly acceptable percentage of failures, "time" is setup as 8760 hours.

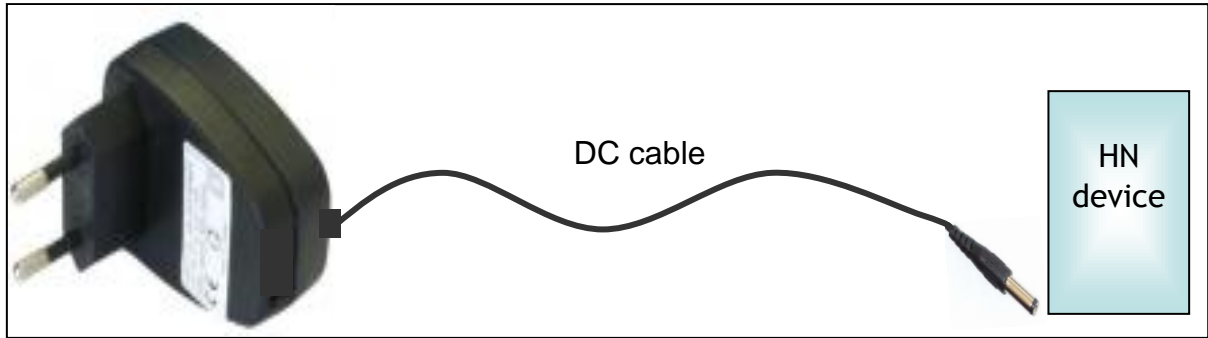


Figure 1 - Type 1 and Type 2-1 power supply configuration

Note that for safety and reliability reasons the DC cable on the secondary side is incorporated in the power supply block; however, a solution providing a completely detachable (from the PS block) DC cable with two connectors i.e. one at each end can be envisaged (although it could add some contact resistance and decrease reliability).

In the case of a Type 2-2 CPS, the power supply needs to provide considerably higher power, up to 60 W. The physical dimensions and weight of the product can become significant thereby causing mechanical reliability problems if the power supply incorporates the AC plug, so that a solution with a second cable to connect the power supply to the mains is indicated.

Note that the connector of the AC cable between the wall and the power supply block could be 2 way or 3 way. The figure shows the case of a two pole connector. If a 3 pole connector is used, it includes a Protective Earth conductor. This Protective Earth conductor must not be connected internally to any of the output low-voltage wires.

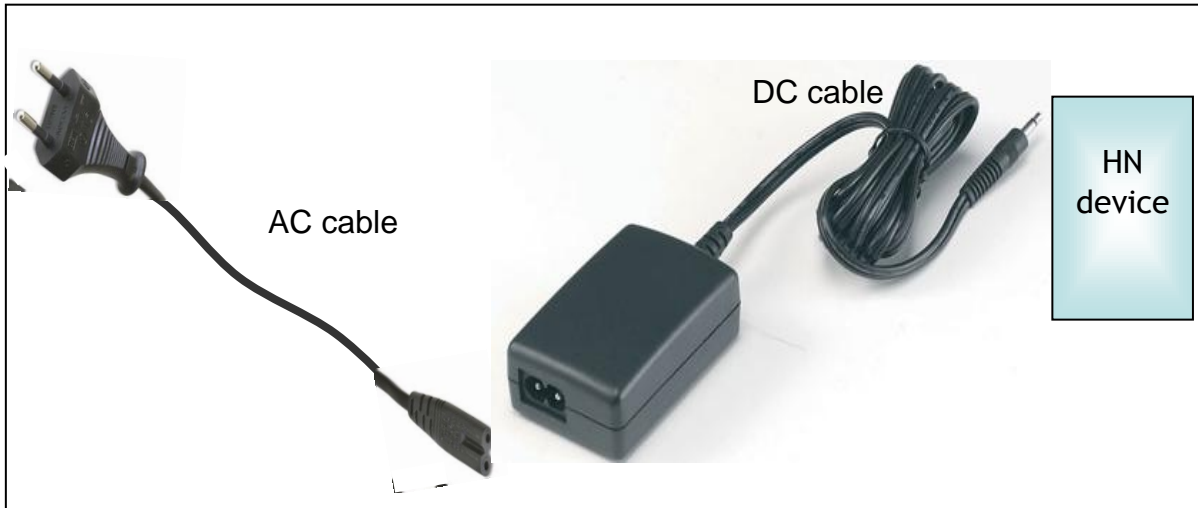


Figure 2 - Type 2-2 power supply configuration

5.5 Coexistence with Powerline Communications

This section describes system considerations related to the use of CPS within a home network where data transmission over powerlines (PLT) is in use. These considerations, which apply regardless of whether the CPS is used to provide power to the PLT device(s) or to other devices, result in requirements on the CPS so as to minimize interference with PLT communications.

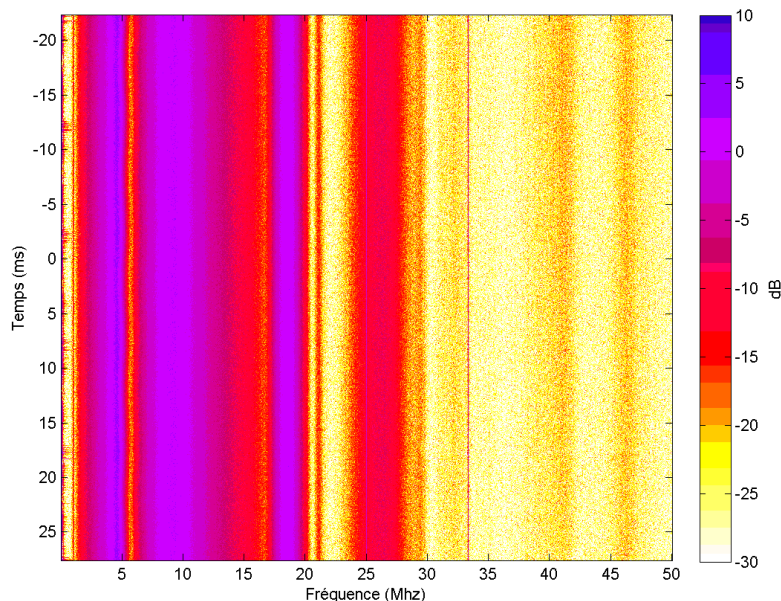
1 In PLT communications, the power wires themselves act as the data transmission medium and use
 2 the spectral region up to 50 MHz (or beyond). It has been noted in the literature [18], and verified in the
 3 laboratories of HGI Service Providers, that switched mode power supplies that are connected to the power
 4 wires can significantly impair the characteristics of the communication channel in this band (the “PLT
 5 band”). As a result, the attainable bit rate of the PLT communications is reduced.

6 The main disturbance introduced by the power supply is caused by variations in the input impedance
 7 (the impedance looking into the AC supply terminals) of the power supply within the PLT band. The input
 8 impedance can vary with time at the frequency of the supply voltage. Because the input impedance
 9 changes when the supply voltage exceeds a threshold, the result is a time-varying impedance at 50 or 60
 10 Hz [18]. Service Provider measurements support the conclusions of [18] that attainable PLT bit rates can
 11 be halved or worse in the presence of this time-varying impedance.

12 It should be noted that various PLT technologies have mechanisms to counteract cyclo-stationary
 13 noise (additive noise in synchronism with the supply voltage) and these mechanisms can partially
 14 counteract the impedance variation.

15 To illustrate the problem, the following charts demonstrate the effect of variation in input impedance
 16 as seen in one measurement by an HGI service provider. In the first chart (Figure 3), the magnitude of the
 17 PLT channel transfer function, which includes the contribution due to the input impedance of a power
 18 supply, is shown in the range 0 to 50 MHz. There is no noticeable variation along the vertical (time) access,
 19 therefore this particular power supply is not affected by the time varying impedance.

20 In the second chart (Figure 4), the same measurement is shown for a PSU which is affected by time
 21 varying impedance. The vertical access shows that at intervals of 10 ms, the magnitude of the transfer
 22 function strongly decreases, as the 50 Hz supply voltage peaks. In this case, one expects a degradation in
 23 PLT performance.



24
 25 Figure 3 Transfer function of PLT line with low impedance variation
 26

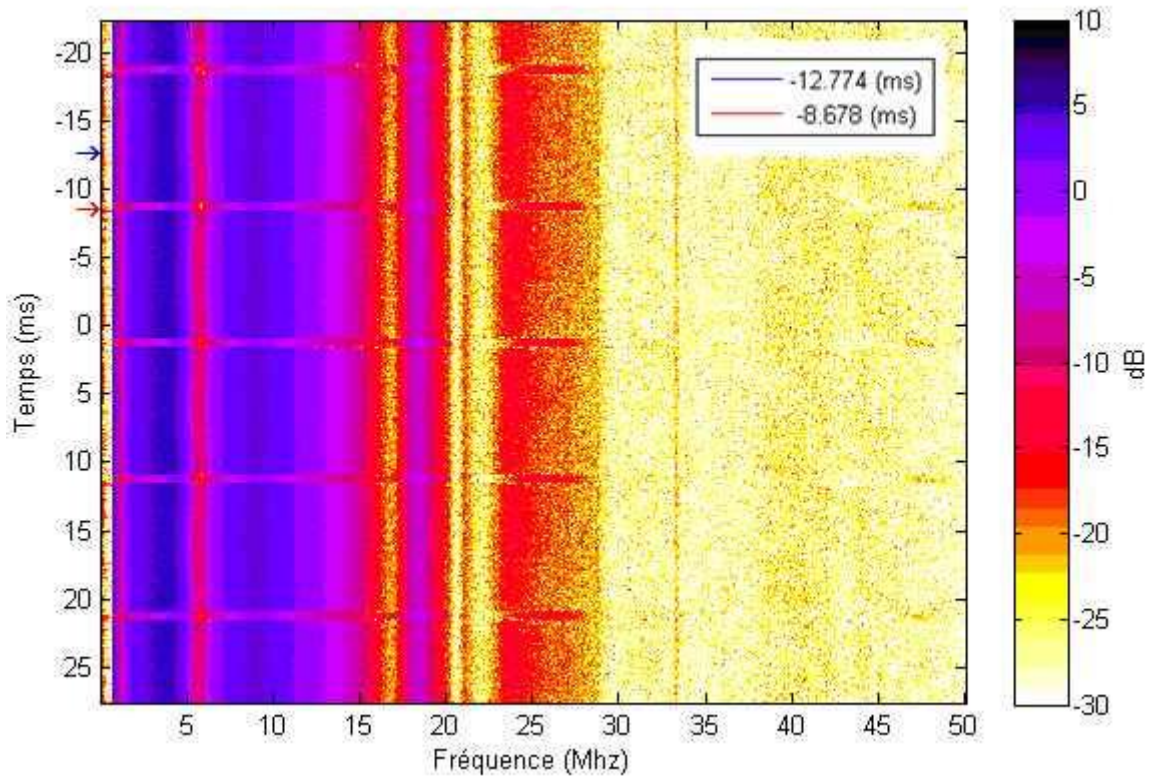


Figure 4 Transfer function of PLT line with high impedance variation

The implication of this analysis is that CPS must be designed so as to minimise time varying impedance changes. Specific requirements for measurement methods and values are for further study.

One potential technique for amelioration of the CPS in this regard is the introduction of filter circuits at the AC input. The following figure is an example of such a filter, with specific values being for further study.

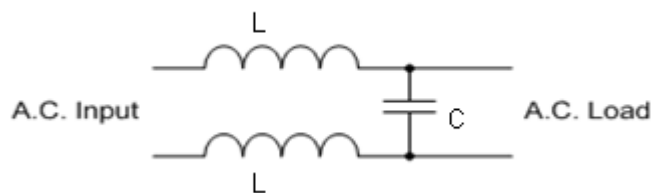


Figure 5 – Example of how to improve coexistence between CPS and PLT technology

6 Requirements for CPS operating conditions

2

N°	Requirements
R.1	All CPS categories MUST support an AC input voltage of 100/240 V (+/-1%) at 50/60 Hz (+/-1%) frequency [6]
R.2	The DC output voltages for all categories MUST remain within +/- 5% of their nominal specified value when measured at the load end of the output connectors under all line, load, and environmental conditions
R.3	CPS Type 1 MUST provide a nameplate output voltage of 5 V (measured at the end plug and with minimum/maximum load)
R.4	CPS Type 2-1 and CPS Type 2-2 MUST provide a nameplate output voltage of 12 V (measured at the end plug and with minimum/maximum load)
R.5	CPS Type 1 MUST support a nameplate output current of 2 A (corresponding to a max. rated output power of 10 W)
R.6	CPS Type 2-1 MUST support a nameplate output current of 2 A (corresponding to a max nameplate rated output power of 24 W)
R.7	CPS Type 2-2 MUST support a nameplate output current of 5 A (corresponding to a max nameplate rated output power of 60 W)

3

6.1 EMC and safety requirements

5 The CPS must be compliant with all the requirements needed to obtain the CE label and to a
 6 number of standards for electrical safety². This implies that the scenario including the possible reuse of the
 7 same power supply with different devices must be treated carefully from the directives' compliance and
 8 liability point of view.

9 Typically a product is labelled as CE compliant when tested together with its specific power supply.
 10 Also, a standalone power supply (e.g. a "common" power supply") can be marked as CE compliant
 11 independent of the product supported. Despite this, the combination of different CE devices coupled with a
 12 CE common power supply may pass or fail CE/immunity tests, as each device implementation/technology
 13 represents a unique type of load with unique sensitivities. At the time of publication of this document, this
 14 issue is expected to be addressed by SDOs (ETSI, IEC, ITU-T).

15 This document does not address the specific issue, being limited to the definition of the technical
 16 specifications for the common power supply.

N°	Requirements
R.8	All CPS categories MUST be compliant to all the harmonised standards requested for CE compliance [9], [10],[11]

² Other regional standards different from CE label may be applicable

N°	Requirements
R.9	<p>An important application of the CPS is as the power source for commonly deployed xDSL modems. All CPS categories MUST be designed so as not to introduce significant interference with the normal operation of xDSL modems</p> <p><i>Note: the following test procedure is suggested to verify the proper operation of a CPS with an xDSL modem. First, the Quiet Line Noise (QLN) [17] is measured, for each DSL subchannel, after DSL line synchronization when the DSL is powered by a reference battery set to the nameplate DC voltage and current corresponding to the CPS category. Second, the QLN is measured for each DSL subchannel after DSL line synchronisation when the DSL is powered by the CPS. The QLN associated with the CPS for each subchannel, and in the aggregate, MUST be within 2 dB of the reference measurement.</i></p>
R.10	<p>To limit interference with Powerline Communications equipment, the AC Power Port conducted emissions MUST NOT exceed 35 dBµV peak and 33 dBµV average in the frequency band from 1.6 MHz to 100 MHz. Other regulatory limits MUST be applied if they define values below these or cover a different frequency area</p>
R.11	<p>As power supplies can introduce significant impedance variations on an AC line used for data transmission over Powerlines, all CPS categories MUST be designed so as not to affect the bit rate of the data over PLT traffic by more than 5% of the reference³ throughput</p>
R.12	<p>To avoid introduction of noise into voice related communications, all CPS categories MUST have a common mode leakage current from primary to secondary side < 10 µA</p>

1 6.2 Reliability

N°	Requirements
R.13	<p>All CPS categories MUST have an expected lifetime of at least 10 years continual operation at maximum output power</p>
R.14	<p>All CPS categories MUST have a minimum MTBF of 300000 hours corresponding to a yearly failure rate of 2.9%</p>

2 6.3 Protection

N°	Requirements
R.15	<p>All CPS categories MUST be compliant with ITU-T K.21 [19] Enhanced level protection requirements</p>

3

³ Note: the following test procedure is suggested to verify the proper operation of a CPS within an environment where PLT communication is occurring on the supply wires: first, the attainable reference error-free throughput is measured, when a load device is powered by a reference battery, set to the nameplate DC voltage and current corresponding to the CPS category. Second, the attainable error-free bit rate is measured when the load device is powered by the CPS connected to the same supply wires as the PLT communications. The bit rate associated with the CPS usage must be within 5% of the reference measurement

1 6.4 Environmental conditions

N°	Requirements
R.16	<p>All CPS categories MUST be able to operate in the following environmental conditions:</p> <ul style="list-style-type: none"> • Temperature: -5°C to +45°C • Relative humidity: 5% to 95% <p>This corresponds to Class 3.2 “Partly temperature-controlled locations” of ETSI EN 300 019-1-3 standard [15]</p>
R.17	<p>All CPS categories MUST be able to withstand the following storage conditions</p> <ul style="list-style-type: none"> • Temperature: -25°C to +55°C • Relative humidity: 5% to 100% <p>This corresponds to Class 1.2 “Weather protected, not temperature-controlled storage locations” of ETSI EN 300 019-1-1 standard [14]</p>
R.18	<p>All CPS categories MUST be withstand the following transportation conditions:</p> <ul style="list-style-type: none"> • Temperature: -40°C to +70°C • Relative humidity: 5% to 100% <p>This corresponds to Class 2.3 “Public transportation” of ETSI EN 300 019-1-2 standard [16]</p>

1 **7 Requirements for CPS energy efficiency**

2 **7.1 Efficiency targets**

N°	Requirements
R.19	All CPS categories MUST be compliant with all the current regional directives and obligations (for European countries, see [2]; for US, see [5])
R.20	The following efficiency targets for CPS Type 1 (10 W) MUST be met: <ul style="list-style-type: none"> • minimum average efficiency of 77% (calculated as average of 25%, 50%, 75%, 100% load) • minimum efficiency of 70% at loads of 10% and above • no-load power consumption < 0.3 W
R.21	The following efficiency targets for CPS Type 2-1 (24 W) MUST be met: <ul style="list-style-type: none"> • minimum average efficiency of 84% (calculated as average of 25%, 50%, 75%, 100% load) • minimum efficiency of 77% at loads of 10% and above • no-load power consumption < 0.3 W
R.22	The following efficiency targets for the CPS Type 2-2 (60 W) MUST be met: <ul style="list-style-type: none"> • minimum average required of 87% (calculated as average of 25%, 50%, 75%, 100% load) • minimum efficiency of 80% at loads of 10% and above • no-load power consumption < 0.3 W

3 **7.2 Efficiency measurement method**

N°	Requirements
R.23	The energy efficiency of all CPS categories MUST be tested according to the common guidelines [6] established by the US EPA Energy Star Program and endorsed by EU, Asia and Australia
R.24	In addition to [6], the following measurements MUST be made and reported: <ul style="list-style-type: none"> - no-load power consumption - efficiency at 25 %, 50 %, 75 % and 100 % of full rated output current - the efficiency at 10% of the full rated output current

1 8 Requirements for CPS connectors

2

N°	Requirements
R.25	Each CPS variant MUST use a unique connector type.
R.26	The different connector types MUST prevent the connection of a given CPS type to a device not designed to be powered by that CPS type.

3

4 A list of recommended connectors for the various categories of CPS is reported in an Annex
5 (Section 11).

1 **9 Requirements for CPS eco-design**

2

N°	Requirements
R.27	The external case of all CPS categories MUST be manufactured using recyclable plastic
R.28	The external case of all CPS categories SHOULD be manufactured using at least 50% recycled plastic (preferred choice: ABS)
R.29	The cables of all CPS categories SHOULD be manufactured using coating materials for coating other than PVC. Preferred choices are Polyolefins and Polyurethane
R.30	The electronic parts of all CPS categories SHOULD be manufactured using materials with low halogenated compound content.
R.31	Provided that all the safety related requirements are satisfied, all CPS categories MUST be designed to enable separation between plastic case and electronics at the end of the CPS life, regardless of the specific disposal processes defined for the product; use of screws must be minimised and snap-fit is preferred.




10 References

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- 8 Supplies - Eligibility Criteria (Version 2.0)
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- 17 [10] EN 55022:2006 + Amendment 1: 2007 - Information technology equipment. Radio disturbance
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- 34 [18] The Influence of Time-varying Channels Synchronized with Commercial Power Supply on PLC
- 35 Equipments, IEEE Symposium on Power Line Communications and Its Applications, April 2008
- 36 [19] ITU-T Recommendation K.21 - Resistibility of Telecommunication Equipment installed in
- 37 Customer Premises to Overvoltages and Overcurrents

11 Annex A – Recommendations on connectors

In order for the CPS concept to work, it will be necessary to agree on a single, unique connector type for each of the 3 CPS variants. The HGI is not the appropriate body to make the final choice, but has come up with some recommendations based on the following considerations.

- the chosen connectors should already be widely adopted by industry for a variety of digital home devices
- the chosen connectors should provide a good user experience, for example with regard to familiarity and ease of handling/insertion
- the chosen connectors must be able to handle the specified current for their respective CPS type, with some safety margin.

	Recommendation	
1.	CPS Type 1 DC cable connector – load device (secondary) side compliant with DIN 45323. The DC power plug for this application could be a 4.0/1.7 mm inlet plug	
2.	As a consequence the load device connected to a CPS Type 1 would be equipped with an outlet connector compliant with DIN 45323 able to be coupled with a 4.0/1.7 mm inlet plug	
3.	CPS Type 2-1 DC cable connector – load device (secondary) side compliant with DIN 45323. The DC power plug for this application could be a 4.95/1.95 mm inlet plug	
4.	As a consequence the load device connected to a CPS Type 2-1 would be equipped with an outlet connector compliant with DIN 45323 able to be coupled with a 4.95/1.95 mm inlet plug	
5.	CPS Type 2-2 DC cable connector – load device (secondary) side compliant with DIN 45323. The DC power plug for this application could be a 5.5/2.1 mm inlet plug	
6.	As a consequence the load device connected to a CPS Type 2-2 would be equipped with an outlet connector compliant with DIN 45323 able to be coupled with a 5.5/2.1 mm inlet plug	
7.	The CPS Type 2-2 could also include a detachable AC cable for connection on the primary side (between the CPS and the AC mains supply). The inlet plug on the AC cable and the outlet connector on the CPS for such power cord could be compliant to IEC 320 C7 and IEC 320 C8 (2 Poles)	