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English version

Powerline communication apparatus used in low voltage installations - Radio disturbance characteristics - Limits and methods of measurement - Part 1: Apparatus for in-home use.

< French translation to be provided >

Powerline communication apparatus used in low voltage installations - Radio disturbance characteristics - Limits and methods of measurement - Part 1: Apparatus for in-home use.

< German translation to be provided >

Powerline communication apparatus used in low voltage installations - Radio disturbance characteristics - Limits and methods of measurement - Part 1: Apparatus for in-home use.

This draft European Standard is submitted to CENELEC members for CENELEC second vote.

Deadline for CENELEC: 2012-xx-xx.

It has been drawn up by CLC/TC 210.

If this draft becomes a European Standard, CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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CENELEC

European Committee for Electrotechnical Standardization

Comité Européen de Normalisation Electrotechnique

Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

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Tables and Figures

Foreword

This document has been prepared by Technical Committee CLC/TC 210, "Electromagnetic compatibility (EMC)".

This document is currently submitted to the Formal Vote.

The following dates are proposed:

– latest date by which the existence of the EN has to be announced at national level	(doa)	dor + 6 months
– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	dor + 12 months
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	dor + 36 months (to be confirmed or modified when voting)

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EN Directive(s). See Annex ZZ.

The scope is extended to the whole radio-frequency range from 9 kHz to 400 GHz, but limits are formulated only in restricted frequency bands, which are considered sufficient to reach adequate emission levels to protect radio broadcast and telecommunication services and to allow other apparatus to operate as intended at reasonable distance.

Introduction

CENELEC draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent given in FprEN50561-1.

CENELEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured CENELEC that he is willing to negotiate licenses under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with CENELEC. Information may be obtained from:

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1 Scope

This European standard specifies limits and methods of measurement of radio disturbance characteristics for in-home communication apparatus that use the low voltage power installation as the transmission medium. This European Standard applies to equipment that **communicate over this medium** in the frequency range 1,6065 MHz to 30 MHz.

NOTE Similar equipment that communicate outside this frequency range is under study and will be covered by another standard

Procedures are given for the measurement of signals generated by the equipment and limits are specified for the frequency range 9 kHz to 400 GHz. No measurement is required at frequencies where no limit is specified.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 55022:2010, *Information technology equipment — radio disturbance characteristics — Limits and methods of measurement (CISPR 22:2008, modified)*

EN 55016-1-1:2010*, Specification for radio disturbance and immunity measuring apparatus and methods — Part 1-1: Radio disturbance and immunity measuring apparatus — Measuring apparatus (CISPR 16-1-1:2010)*

EN 55016-1-2:2004, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 1-2: Radio disturbance and immunity measuring apparatus — Ancillary equipment — Conducted disturbances (CISPR 16-1-2:2003)*

EN 55016-4-2:2004, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 4-2: Uncertainties, statistics and limit modelling — Uncertainty in EMC measurements (CISPR 16-4-2:2003)*

The Radio Regulations, Edition of 2008.

ITU-R Recommendation BS.560-3: "Radio-frequency protection ratios in LF, MF and HF broadcasting".

ITU-R Recommendation BS.1615: "Planning parameters" for digital sound broadcasting at frequencies below 30 MHz".

ITU-R Recommendation BS.703: "Characteristics of AM sound broadcasting reference receivers for planning purposes".

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
AC mains power port
port that connects to the low voltage AC mains power network for the sole purpose of supplying electrical energy to the EUT

3.2
AC mains output port
port of the EUT that provides AC mains power to other apparatus

3.3
Artificial Mains Network
AMN
provides a defined impedance at high frequencies across the power feed at the point of measurement of the terminal voltage. It also provides isolation of the circuit under test from the ambient noise on the power lines. Such a network with a nominal impedance of 50 Ω/50 µH or 50 Ω/50 µH + 5 Ω is defined in 4.3 of EN 55016-1-2

3.4
Associated Equipment
AE
equipment needed to maintain the data traffic on the cable attached to the EUT port under test and (or) to maintain the normal operation of the EUT during the test. The associated equipment may be physically located outside the test area

NOTE The AE can be another ITE, a traffic simulator or a connection to a network. The AE can be situated close to the measurement set-up, outside the measurement room or be represented by the connection to a network. AE should not have any appreciable influence on the test results.

3.5
Equipment Under Test
EUT
representative equipment used for evaluation purposes

3.6
Impedance Stabilization Network
ISN
symmetrical network for the measurement of the launched common mode disturbance signal transmitted by the EUT

3.7
in-Home PLC apparatus
PLC apparatus that connects to the low voltage AC mains power network and intended to be linked to other PLC apparatus connected in the same home

3.8
Information Technology Equipment
ITE
any equipment:

a) which has a primary function of either (or a combination of) entry, storage, display, retrieval, transmission, processing, switching, or control, of data and of telecommunication messages and which may be equipped with one or more terminal ports typically operated for the transfer of information.

b) with a rated supply voltage not exceeding 600 V.

NOTE 1 ITE includes, for example, data processing equipment, office machines, electronic business equipment and telecommunication equipment.

NOTE 2 Any equipment (or part of the ITE equipment) which has a primary function of radio transmission and/or reception according to the ITU Radio Regulations is excluded from the scope of this publication

NOTE 3 Any equipment which has a function of radio transmission and/or reception according to the definitions of the ITU Radio Regulations should fulfil the national radio regulations, whether or not this publication is also valid.

3.9
PLC apparatus
apparatus with a PLC port

NOTE PLC apparatus are also called PLT apparatus

3.10
PLC port
port that connects to the low voltage AC mains power network for the purpose of data transfer and communication, and may also supply electrical energy to the EUT

NOTE PLC ports are also called PLT ports

3.11
telecommunications/network port
point of connection for voice, data and signalling transfers intended to interconnect widely-dispersed systems via such means as direct connection to multi-user telecommunications networks (e.g. public switched telecommunications networks (PSTN) integrated services digital networks (ISDN), x-type digital subscriber lines (xDSL), etc.), local area networks (e.g. Ethernet, Token Ring, etc.) and similar networks

NOTE 1 A port generally intended for interconnection of components of an ITE system under test (e.g. RS-232, IEEE Standard 1284 (parallel printer), Universal Serial Bus (USB), IEEE Standard 1394 (“Fire Wire”), etc.) and used in accordance with its functional specifications (e.g. for the maximum length of cable connected to it), is not considered to be a telecommunications/network port under this definition.

NOTE 2 A PLC port is not considered a telecommunications network port in the sense of this definition.

3.12
User Data
data originated from or destined to another device

3.13
‘valid’ radio broadcast service
radio broadcast service for which the field strength of the wanted radio signal at the location of the radio broadcast receiver is either at or above the minimum usable field strength level of 40 dB(µV/m) as defined by the Radio Regulations and ITU R BS.703

4 Requirement for conducted disturbances at AC mains power ports

The AC mains power ports of the EUT shall comply with the Class B limits, using the measurement conditions and the methodology defined in EN 55022 for mains terminals.

5 Requirement for conducted disturbances at telecommunication/network ports

The Telecommunications/network ports of the EUT shall comply with the Class B limits, using the measurement conditions and the methodology defined in EN 55022 for these ports.

6 Requirements for conducted disturbances and communications signals at PLC ports

6.1 General requirements

The PLC port of the EUT shall comply with the following requirements:

In any operating condition the unsymmetrical disturbances from the PLC port shall not exceed the disturbance limits given in Table 1 between 150 kHz and 1,6065 MHz using the methods and procedures given in 9.1.

When user data is being transmitted by the PLC port the disturbances from the PLC port may exceed the disturbance limits of Table 1 at frequencies between 1,6065 MHz and 30 MHz provided that within:

- all the excluded frequency ranges given in Table A.1 — the level of the transmitted signals shall comply with the disturbance limits given in Table 1 using the methods and procedures given in 9.1.

- all the excluded frequency ranges given in Table A.2 the level of the transmitted signals shall either comply with:

    - o the disturbance limits given in Table 1 using the methods and procedures given in 9.1.

  or

    - o the dynamic frequency exclusion requirements given in 6.2.

Without user data transmission, the unsymmetrical disturbances from the PLC port shall comply with the disturbance limits given in Table 1 between 150 kHz and 30 MHz using the methods and procedures given in 9.1.

The maximum transmitted signal from the PLC port shall not exceed the maximum values given in Table 2 measured using the methods and procedures given in 9.2.

The PLC port shall implement a dynamic power control function for the purpose of minimising the probability of radio disturbance whilst still maintaining communication. The dynamic power control function shall be capable of reducing the output power to the maximum levels given in Table 2 measured using the methods and procedures given in 9.2.

In order to ensure the inherent symmetry of the PLC port it shall, in all operating conditions, comply with the disturbance limits given in Table 1 using the methods and procedures given in 9.4.

Table 1 — Limits for conducted disturbances

Frequency range MHz	**Limits** dB(μV)	
	Quasi-peak	Average
0,15 to 0,50	66 to 56	56 to 46
0,50 to 5	56	46
5 to 30	60	50
NOTE 1 The lower limit applies at the transition frequencies. NOTE 2 The limit decreases linearly with the logarithm of the frequency in the range 0,15 MHz to 0,50 MHz.		

Table 2 — Maximum PLC transmit signal level between 1,6065 and 30 MHz

Symmetrical mode insertion loss EUT to AE (dB)	10	20	≥ 40
Maximum transmitted signal in dB(μV) (AV)	65	75	95
Maximum transmitted signal in dB(μV) (PK)	75	85	105
NOTE The transmit power management function of an AE should function in the same way as the EUT otherwise the signal of the AE may dominate and cause erroneous results during measurement.			

6.2 Specific requirements for Dynamic Frequency Exclusion

Within 15 seconds of a 'valid' HF radio broadcast service being present within the excluded frequency band given in Table A.2 the transmitted PLC signal level shall not exceed a symmetrical voltage level of 56 dB(µV) (AV) in a 9 kHz resolution bandwidth.

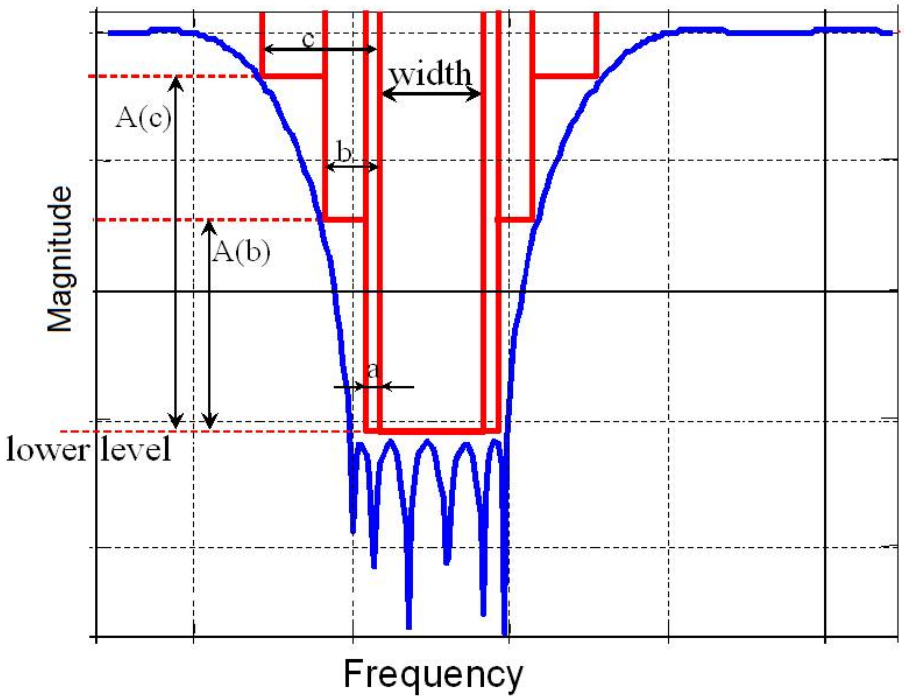
NOTE 1 This level of the symmetrical voltage is derived from the EN 55022 Mains Conducted Class B disturbance limit (5 MHz to 30 MHz), which is U_{AMN} = 50 dB(µV) (Resolution Bandwidth 9 kHz, AV).

The transmitted PLC signal shall avoid using the frequency of an identified radio broadcast service. The minimum width of the excluded frequency band shall be 10 kHz (+/- 5 kHz centred on the carrier frequency of the broadcast signal). The excluded frequency band shall also comply with the requirements of Figure 1 in order to avoid adjacent channel interference, with respect to AM / DRM protection ratios as defined in ITU-R Rec. BS.560-3, BS.1615 and BS.703, from transmissions outside the notch.

If several neighbouring radio broadcast services are identified or a digital (DRM) service occupying more than a single conventional channel, the width of the excluded frequency range shall be increased, scaled to integer multiples of 5 kHz.

NOTE 2 Usually, the channels of radio broadcast services are allocated with a minimum spacing of 5 kHz. Also, the centre frequency is a multiple of 5 kHz.

The excluded frequency band shall remain excluded continuously for the entire duration that the 'valid' radio broadcast service is present. After the detection of a 'valid' radio broadcast service has ceased, the excluded frequency band shall remain excluded for at least 3 additional minutes.



Where width ≥ 10 kHz, lower level = 56 dB(µV) (AV, Resolution bandwidth 9 kHz) and

	Frequency width [kHz]	Distance from lower level of the notch: A(x) [dB]
Step a	2	0
Step b	10	≤ 25
Step c	20	≤ 35

Figure 1 — Minimum requirements for a dynamically excluded frequency range

7 Requirement for radiated disturbances

The EUT shall comply with the Class B limits, using the measurement conditions and the methodology defined in EN 55022 for radiated disturbances.

8 Measurement conditions for PLC ports

The measurement of PLC ports shall be performed in conformance with clause 8 of EN 55022:2010.

The tests requiring the PLC modem function to be active shall be performed with the condition of PLC utilisation in excess of 10 % and with the transmit signal set at its maximum level maintained for a minimum of 250 ms. As an example the transmission of a large data file could be used to exercise the port. Where this is not possible an appropriate configuration should be used that ensures the PLC transmission is active for a period of time long enough to allow for repeatable measurements in this state.

< Note to the NC's (not to be included in final standard): "10 % utilisation" comes from EN 55022 (and CISPR 22); if a better wording comes in EN 55022 (or in future EN 55032), it will be taken over in the next revision of this standard >

No connection shall be made to any AC mains output port.

9 Measurement methods and procedures for PLC ports

9.1 Conducted unsymmetrical disturbances

The PLC port of the EUT shall be assessed using an AMN in accordance with Sub-Clause 4.3 of EN 55016-1-2, , the measurement method given in Clause 9 of EN 55022, for the mains ports and the arrangement shown in Figure 2 below for frequencies between 150 kHz and 30 MHz.

The Coupling System (see Figure 3) shall:

- Allow the EUT to be exercised by the AE;
- Have sufficient loss to ensure signals from the AE do not influence the measurement result;
- Ensure that the EUT can transmit at its maximum power level.

The insertion loss (symmetric) of the Coupling System between its two ports is required for:

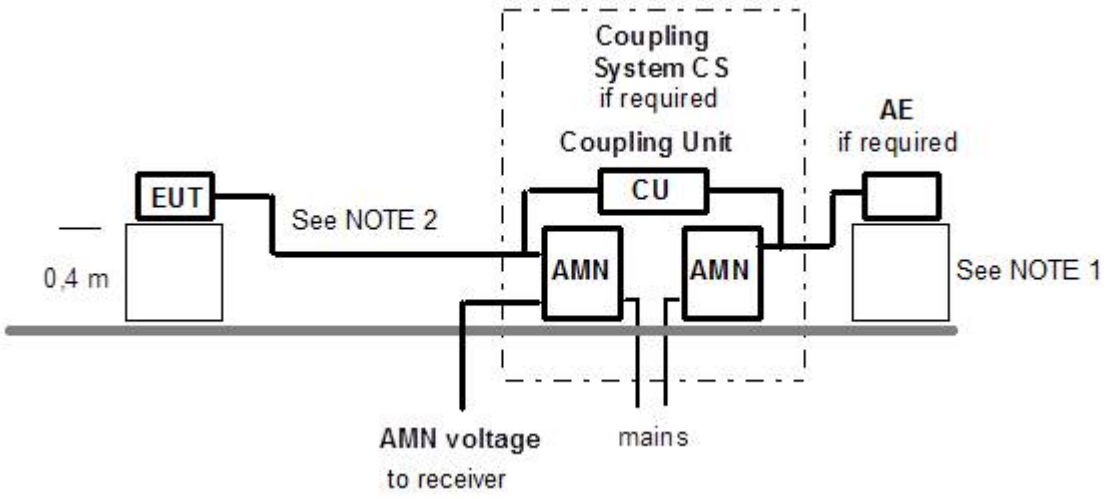
- providing a defined insertion loss between the EUT and AE
- stabilization of the differential mode impedance;
- attenuation of the differential mode signal of the AE;
- isolation of the common mode signal of the AE;
- filtering of the differential- and common mode signal from the mains

Figure 3 shows an example of a coupling unit with a nominal insertion loss of 40 dB.

Measurements in the following operating conditions and configurations shall be performed:

1. with the PLC modem function of the EUT active and communicating to an associated PLC apparatus (AE) exercised in accordance with Clause 8, using its maximum transmit power the disturbance levels shall be measured in the frequency range from 150 kHz to30 MHz. Above 1,6065 MHz only the disturbances within the appropriate excluded frequency ranges need to be compared with the limits;

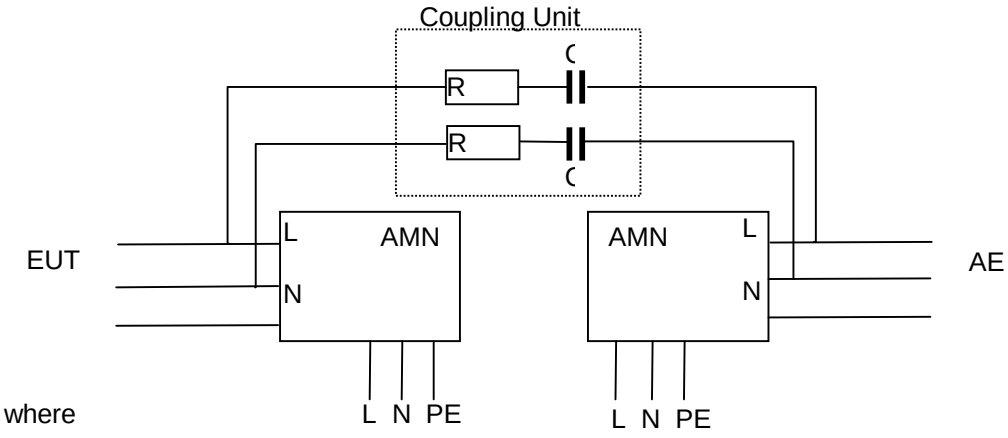
2. after completion of step 1, the exchange of user data exercising the EUT shall be terminated. Without user data transmission, the disturbance levels shall be measured between 150 kHz – 30 MHz.



NOTE 1 Distance from AE to the reference ground plane (vertical or horizontal) is not critical

NOTE 2 Cable length between EUT and CS is 0,8 m (+/- 0,05 m).

Figure 2 — Test arrangement for measuring the PLC port with an AMN



where

R = 2,5 kOhm;

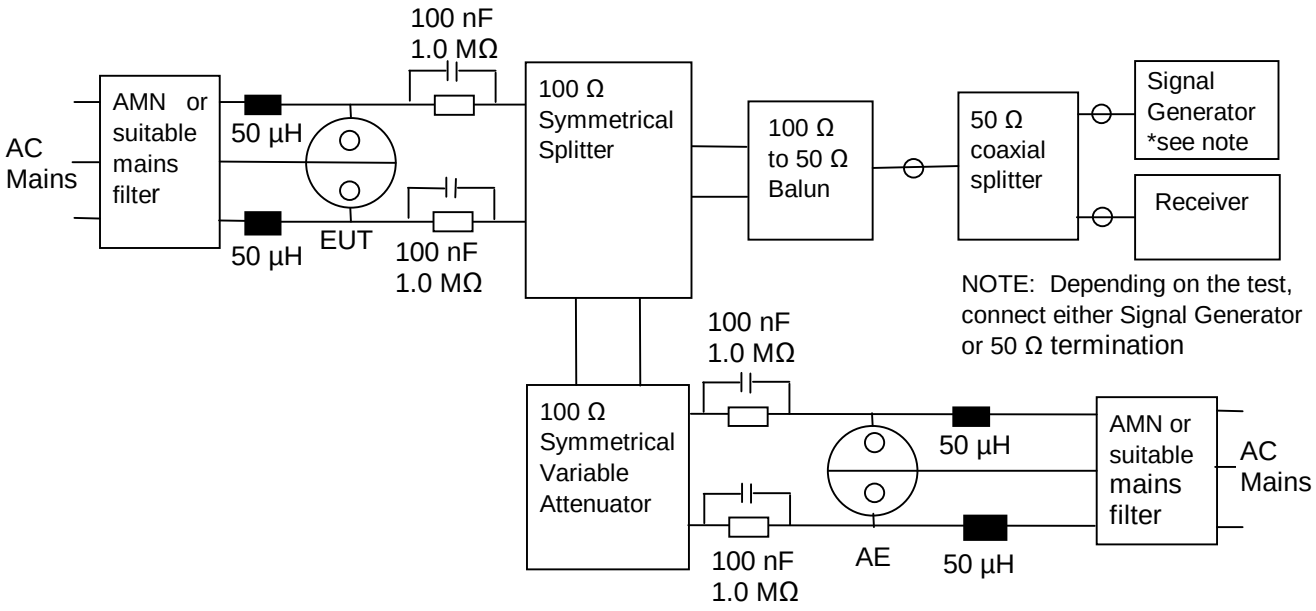
C = 1 nF.

Figure 3 — Example coupling unit

9.2 Dynamic power control

The transmitted symmetrical signal from the PLC port of the EUT shall be measured for frequencies between 1,6065 MHz and 30 MHz in order to ensure that the maximum transmit signal levels are not exceeded and to ensure the presence of a dynamic power control function. The PLC port shall be exercised in accordance with the operating conditions given in Clause 8. The measurements shall be made using a Peak and an Average detector; the detectors shall be in accordance with the requirements of EN 55016-1-1 including the 9 kHz requirement for the 6 dB bandwidth. An example test arrangement is given in Figure 4.

The transmit signal level shall be measured at all PLC transmission frequencies, with a symmetrical insertion loss between EUT and AE of 10 dB, 20 dB, 40 dB and 50 dB.



NOTE 1 The insertion power loss between the EUT and the AE is 10 to 50 dB adjustable in 10 dB steps.

NOTE 2 The insertion power loss between the EUT and the measurement receiver is nominally 20 dB.

NOTE 3 The insertion power loss between the signal generator and EUT is nominally 20 dB.

NOTE 4 The insertion power loss between the signal generator and the measurement receiver is nominally 6 dB.

NOTE 5 The above losses are determined as a part of the test equipment calibration; the actual figures should be used to correct the instrument readings to determine the levels that apply at the EUT terminals.

Figure 4 — Example test equipment arrangement for measuring PLC transmit signal levels

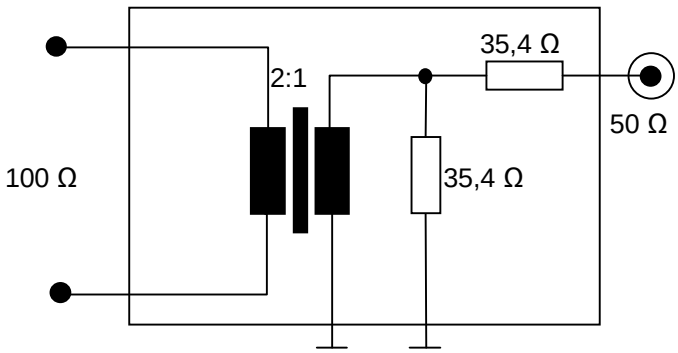


Figure 5 — Example schematic of 100 Ω to 50 Ω Balun

9.3 Cognitive frequency exclusion

This Sub-Clause provides an option for demonstrating compliance of the EUT with the requirements given in 6.2 for dynamic frequency exclusion. The EUT shall comply with the requirements of Annex C when tested using ingress signals in the excluded frequency ranges given in Table A.2. The measurement should be carried out using the arrangement given in Figure 4 of this European Standard.

NOTE Other options are under development.

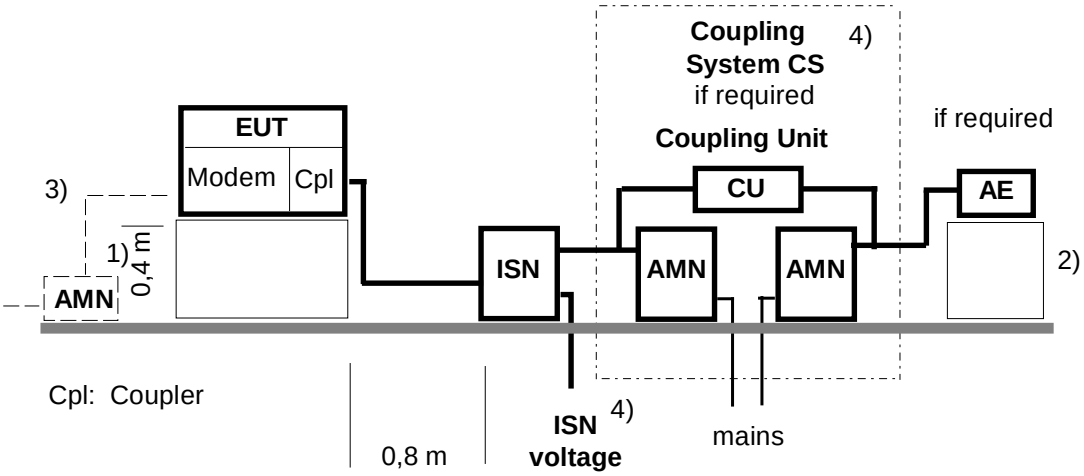
For testing purposes, a radio broadcast service shall also be considered as 'valid' if the conducted signal appearing at the PLC port of the EUT in the test setup according to Figure 4 is ≥ -95 dBm (in 9 kHz resolution bandwidth with an Average detector).

9.4 Conducted asymmetric disturbances

The conducted asymmetric disturbances at the PLC port of the EUT shall be measured using the arrangement shown in Figure 6.

The insertion loss (symmetric) between the two ports of the Coupling System shall be such that the link to the AE works properly and that the EUT transmits at its maximum power level. Figure 3 shows an example coupling unit with a nominal insertion loss of 40 dB.

The ISN used shall have the characteristics specified in Annex B and shall be bonded directly to the reference ground plane.



NOTE 1 Distance from EUT to the reference ground plane (vertical or horizontal).

NOTE 2 Distance from AE to the reference ground plane is not critical.

NOTE 3 In case the EUT has separate power connection to the mains.

NOTE 4 Coupling System (see Figure 3 for details of coupling unit) is required for

- providing a defined insertion loss between the EUT and AE,
- stabilization of the differential mode impedance,
- attenuation of the differential mode signal of the AE,
- isolation of the common mode signal of the AE,
- filtering of the differential- and common mode signal from the mains.

Figure 6 — Test arrangement for measuring the conducted asymmetric disturbances from the PLC port

10 Measurement Uncertainty

The results of measurements of signals or disturbances from PLC apparatus shall reference the measurement instrumentation uncertainty considerations where they are contained in EN 55016-4-2.

Determining compliance with the limits in this standard shall be based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty. However, the measurement uncertainty of the measurement instrumentation and its associated connections between the various instruments in the measurement chain shall be calculated and both the measurement results and the calculated uncertainty shall appear in the test report.

Annex A
(normative)

Excluded frequency ranges

Where frequency ranges overlap, due to dual use, between Table A.1 and Table A.2 the permanently excluded range in Table A.1 takes precedence.

Table A.1 — Permanently excluded frequency ranges

Excluded frequency range (MHz)	Service
1,80 – 2,00	Amateur Radio Service
2,85 – 3,025	Aeronautical mobile
3,40 – 4,00	Aeronautical mobile (3,40-3,50) Amateur Radio Service (3,50-4,00)
4,65 – 4,70	Aeronautical mobile
5,25 – 5,41	Amateur Radio Service
5,48 – 5,68	Aeronautical mobile
6,525 – 6,685	Aeronautical mobile
7,00 – 7,30	Amateur Radio Service
8,815 – 8,965	Aeronautical mobile
10,005 – 10,15	Aeronautical mobile (10,005-10,10), Amateur Radio Service (10,10-10,15)
11,275 – 11,4	Aeronautical mobile
13,26 – 13,36	Aeronautical mobile
14,00 – 14,35	Amateur Radio Service
17,9 –17,97	Aeronautical mobile
18,068 – 18,168	Amateur Radio Service
21,00 – 21,45	Amateur Radio Service
21,924 – 22,00	Aeronautical mobile
24,89 – 24,99	Amateur Radio Service
26,96 – 27,41	CB radio
28,00 – 29,7	Amateur Radio Service

Table A.2 — Permanent or dynamically excluded frequency ranges

Excluded frequency range (MHz)	Service
2,30 – 2,498	Broadcasting
3,20 – 3,40	Broadcasting
3,90 – 4,05	Broadcasting
4,75 – 5,11	Broadcasting
5,75 – 6,20	Broadcasting
7,20 – 7,70	Broadcasting
9,30 – 9,95	Broadcasting
11,55 – 12,10	Broadcasting
13,55 – 13,90	Broadcasting
15,05 – 15,85	Broadcasting
17,40 – 17,90	Broadcasting
18,90 – 19,02	Broadcasting
21,45 – 21,85	Broadcasting
25,65 – 26,10	Broadcasting
NOTE The bands in this table include frequency ranges allocated under Article 5 of the Radio Regulations to the Broadcasting Service, plus a realistic appraisal of use for broadcasting under Article 4.4 of the Radio Regulations.	

Annex B
(normative)

Impedance Stabilisation Network (ISN) for asymmetric disturbance measurements

The ISN shall meet the following specifications in the frequency range of 1,6065 MHz to 30 MHz:

— the common mode termination impedance at the EUT port shall be 25 Ω +/- 3 Ω, phase angle 0^o +/- 25^o;

— the differential mode impedance of the EUT port with the CS port terminated with 100 Ω +/- 1% shall be 100 Ω +/- 10 Ω, phase angle 0^o +/- 25^o;

— the decoupling attenuation (common mode isolation of the ISN excluding the Coupling System) between CS port and the ISN voltage port shall be:

$$a_{CISN} = 20 \log (E_{CISN} / 2^* V_{CISN}) \geq 55 \text{ dB minus Voltage Division factor}$$

NOTE 1 The Voltage Division factor, as defined in EN 55016-1-2, is normally a negative figure, thus it normally increases the required a_{CISN}.

NOTE 2 The measurement arrangement for the common mode isolation a_{CISN} is shown in Figure B.2

- The longitudinal conversion loss (LCL) of the ISN measured at the EUT port with the CS port terminated with 100 Ω +/- 1 % shall be ≥ 55 dB;

- The attenuation distortion or other deterioration of the quality of signal quality in the wanted signal frequency band caused by the presence of the ISN shall not affect the normal operation of the EUT;

An example of a schematic diagram of an ISN is shown in Figure B.1.

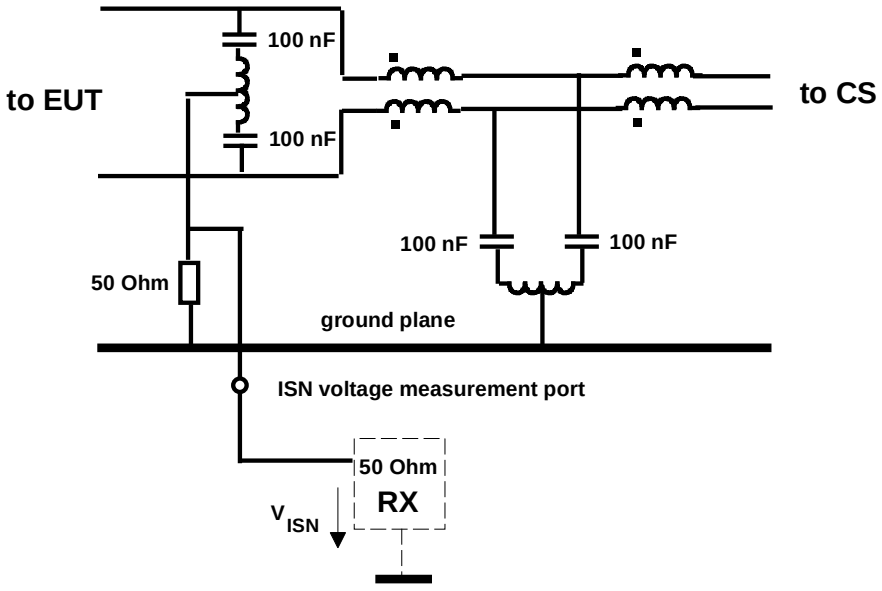


Figure B.1 — Example circuit schematic for ISN

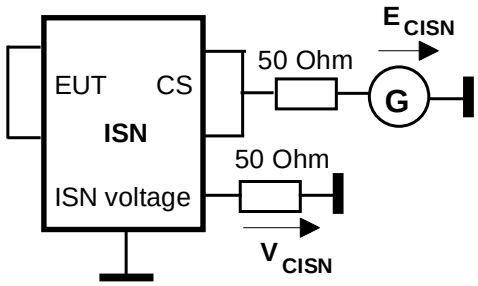


Figure B.2 — Arrangement for measurement of the ISN common mode decoupling attenuation (isolation) (excluding the Coupling System)

Annex C
(informative)

Cognitive Frequency Exclusion

NOTE This annex is derived from the relevant parts of ETSI TS 102 578 V1.2.1 (2008-08).

C.1 Abbreviations

For the purposes of this annex, the following abbreviations apply:

AM Amplitude Modulation

DRM Digital Radio Mondiale (See ES 201 980 or http://www.drm.org/).

C.2 PLC apparatus Broadcast Radio detection

C.2.1 Overview

Signals from radio broadcast stations ingress onto the AC mains power network of homes. These ingress signals can be detected by PLC modems by comparing the ingress signal level at the PLC port with the noise floor.

C.2.2 Noise Floor

The noise floor shall be measured by the PLC modem at adjacent frequencies lower and higher than the Broadcast Radio bands given in Table A.2. The adjacent frequency block to be monitored shall be as wide as the Radio band allocation itself. The adjacent frequency blocks must be completely monitored by the PLC modems without any gaps. The noise floor is the median value of all measured values of the electrical energy in the adjacent frequency blocks on the Powerline channel excluding all Powerline communication signals. An individual noise floor level shall be calculated for each Broadcast Radio band. The frequency locations and resolution bandwidth of the measured values is dependent on the PLC modem implementation.

A short impulsive noise e.g. caused by a light switch must not influence the noise floor measurement.

C.2.3 Levels and Thresholds

Signal ingress shall be identified as a receivable radio broadcast service if the signal is at least:

Criterion (1): 14 dB above the noise floor

If criterion (1) is satisfied, the threshold level of ingress of a broadcast signal identified as receivable is:

Criterion (2): $\geq$ -95 dBm (9 kHz Resolution Bandwidth, AV)

Additionally PLC modems may limit the identification of a receivable radio broadcast service to such signals that are AM or DRM modulated including very low AM modulated signals (plain carrier or a silent period).

The noise floor and Broadcast Radio signal shall be measured between the live and neutral conductor at the socket to which the PLC modem is connected. The measurement shall be made using a spectrum analyser or measurement receiver specified and adjusted as in clause 6 of EN 55016-1-1.

The threshold is defined to take into account the sensitivity of Broadcast Radio receivers and reception factor between the field and the signals on the mains. The measurement bandwidth and detectors specified here are for verification of the implementation of the present document, which is described in detail in C.3.2. Resolution bandwidth and detectors used by the PLC modem are implementation dependent.

Taking into account the fading effects defined in ITU-R Rec. BS.1615 and the robustness of radio receivers ES 201 980 the signal is considered to be present if Criterion (1) and (2) is exceeded for at least 30 % of time in any 10 seconds interval.

C.3 Verification of the cognitive frequency exclusion implementation

C.3.1 Measurement arrangement

The implementations of Cognitive frequency exclusion shall be verified using the measurement apparatus and arrangement shown in Figure 4.

C.3.2 Spectrum Analyser Settings

The spectrum analyser shall be configured as follows:

Centre Frequency:	Carrier Frequency of Signal Ingress
Frequency Span:	200 kHz
Resolution Bandwidth:	300 Hz
Video Bandwidth:	3 kHz
Detector:	Average or Peak

C.3.3 Artificial Signal Ingress

Signal ingress shall be one or several signals of:

- AM-Radio: modulated with a 1 kHz sine wave, 30 % Modulation Depth; or
- DRM: ES 201 980;

at various frequencies. The strength of individual signals shall be equal to or higher than the level defined in C.3.4.

C.3.4 Levels and thresholds at verification-bench

C.3.4.1 Level of signal ingress

Using the arrangement shown in Figure 4 and the settings defined in C.3.2, the thresholds given in C.2.3 are verified by integrating the energy of the measured frequency points to a measurement bandwidth of 9 kHz (according to EN 55016-1-1:2010). Usually Spectrum Analysers have a built-in function to do this. The attenuation of the measurement apparatus must be added to the values from criterion (2).

The level of individual artificial signal ingress shall exceed these thresholds to enable a PLC modem to cognitively exclude these frequencies.

C.3.4.2 Lower level of the excluded frequency range

The lower level of the excluded frequency range shall be measured with the Spectrum Analyser configured in accordance with C.3.2. The measured Average level shall be less than -89 dBm (see Note below for further detail on this value).

NOTE

The lower level of the excluded frequency range is derived from EN 55022:2010 Class B mains conducted disturbance limit (5 MHz to 30 MHz) which is U_{AMN} = 50 dB(µV) (Resolution Bandwidth 9 kHz, AV)

For verification of the mains port limits, an AMN (artificial mains network, specified in EN 55016-1-1) is used. It measures half of the differentially fed voltage at the measurement output. It follows that at the outlet U_{outlet} where the PLT modem is connected, twice the differential voltage is present.

$$U_{outlet} = U_{AMN} \cdot 2 = 50 \text{ dB}(\mu\text{V}) + 6 \text{ dB} = 56 \text{ dB}(\mu\text{V})$$

Conversion from dB(µV) to dBm, using $Z = 100$ Ohm Conversion factor of 110 dB(mW/µV):

$$P_{outlet} = 56 \text{ dB}(\mu\text{V}) - 110 \text{ dB}(\text{mW}/\mu\text{V}) = -54 \text{ dBm}$$

P_{outlet} of PLT Modem at lower level of the excluded frequency range converting it to 300 Hz as specified in C.3.2:

$$P_{outlet} = -54 \text{ dBm} - 10 * \log_{10}\left(\frac{9 \text{ kHz}}{300 \text{ Hz}}\right)$$

$$= -54 \text{ dBm} - 14{,}7 \text{ dB} = -68{,}7 \text{ dBm}$$

Considering the 20 dB attenuation of the measurement apparatus shown in Figure 4 the value displayed on the spectrum analyser should be

$$P_{displayed} = -68{,}78 \text{ dBm} - 20 \text{ dB} = -88{,}78 \text{ dBm (rounded to -89 dBm)}$$

C.3.5 Test procedure

The PLC System shall transport maximum payload as a continuous transmission. The following test sequence shall be performed.

Prepare the artificial ingress signal with 20 individual signals within the frequency ranges defined in Table A.2 and the communication spectrum of the EUT. The signal level of each individual ingress signal shall be as defined in C.3.4.1. A test signal is defined in C.4.

Tune the Spectrum Analyser to Centre frequency of the 1st artificial ingress signal.

Switch artificial signal ingress on.

Monitor the Spectrum Analyser to confirm that the PLC signal is excluded and measure the excluded frequency range to ensure it complies with the requirements defined in 6.2.

Tune to all other frequencies where an artificial ingress signal is located.

Switch the artificial ingress signal off and monitor the Spectrum Analyser, to confirm that the PLC signal is not reused within the time specified in 6.2.

C.4 Test Signals

A file containing a definition of a suitable test signal is available from
http://pda.etsi.org/exchangefolder/ts_102578v010201p0.zip

The test signal modulates 20 individual signals within the HF Broadcasting Bands:

- 10 AM signals generated at the following frequencies:

- 4,75 MHz, 5,9 MHz, 7,2MHz, 11,6 MHz, 11,62 MHz, 11,65 MHz, 11,69 MHz, 15,1 MHz, 21,45 MHz, 25,67 MHz.

- 10 DRM signals generated at the following frequencies:

  - 4,89 MHz, 6,2 MHz, 7,45 MHz, 11,61 MHz, 11,63 MHz, 11,66 MHz, 12,1 MHz, 15,8 MHz, 21,85 MHz, 26,1 MHz.

AM and DRM signals alternate in the frequency domain.

Frequencies are chosen to be located close to the margins of the HF Broadcasting Bands. They are slightly modified to fit into a carrier spacing of 5 kHz and an integer number of wavelengths of the carrier frequency that needs to fit into the total signal length.

A group of 4 adjacent carriers should be generated (11,6 MHz, 11,61 MHz, 11,62 MHz, 11,63 MHz), one gap (11,64 MHz), 2 more carriers (11,65 MHz, 11,66 MHz), 2 gaps (11,67 MHz, 11,68 MHz) and one more carrier (11,69 MHz).

The Sampling Frequency is 80 MHz. Total Signal Length is 2 133 760 samples (26,7 ms).

Bibliography

ETSI ES 201 980 (V2.2.1): "Digital Radio Mondiale (DRM); System Specification"

ETSI TS 102 578 v1.2.1:2008, PowerLine Telecommunications (PLT); Coexistence between PLT Modems and Short Wave Radio broadcasting services