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Title:
CISPR22 - Limits and method of measurement of broadband telecommunication equipment over power lines

(Titre) :

Introductory note

1. Introductory note

1.1 History

The definition of the measurement methods and of the emission limits for power line telecommunications (PLT) systems has been a pending issue for many years. Following the decision 10a made at the Shanghai meeting of CISPR/I (see CISPR//131/RM), a new work item proposal CISPR//145/NP was submitted and adopted (see CISPR//156/RVN). It established the project team CISPR//PT PLT whose goal was to issue an amendment to CISPR 22 for broadband telecommunication equipment over power lines.

The project team issued two documents: CISPR//186/DC, a description of electric network topologies, and CISPR//211/DC, identifying the potentially disturbed equipment and giving a preliminary description of the coupling paths. Comments are compiled in CISPR//191/INF and CISPR//218/INF, respectively.

Twenty one classes of equipment configurations are identified in CISPR//211A/DC.

The project team studied more than 90 contributions dealing with all the tasks of the work plan as described in CISPR//186/DC, in particular with the characteristics of the coupling paths, for both the radiation from the mains to the victim and the conduction.

The Japanese approach and an earlier proposal of the German administration, both with a test setup using a T-ISN of 25 Ω common mode impedance, were analyzed in detail.

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This CD is a result of these studies performed and it summarizes contributions made in CISPR/1/PT PLT.

The PT PLT is also working on adaptive dynamic notching and adaptive power management techniques for potential inclusion in any future CD or CDV related to PLT equipment.

The PT PLT also prepared a draft document intended to become a Technical Report on mitigation factors and methods for Power Line Communications that is circulated simultaneously with the present CD under the reference CISPR/1258/DC with the intention to take NC comments into account before circulation as a DTR.

Note: This document supersedes CISPR/1/89/CD.

1.2. Scope

In CISPR 22, conducted disturbances of ITE are measured at the mains terminals and at the telecommunications port separately. Most PLT devices however use one port for both purposes (mains power supply and telecommunications). This leads to the definition of the "PLT port", which is not yet defined in CISPR 22 Ed. 5.2 (2006).

This CD deals with measurement methods and emission limits for power line telecommunications (PLT) devices connected to the mains at the customer premises. These PLT devices may establish network termination or provide local connections to other PLT devices connected at the same premises. They are called "Indoor" PLT devices.

1.3. Technical background

The goal of the technical work is to provide a protection for the equipment and radio services equivalent to the protection provided by the test methods and limits defined in the CISPR22.

The test method proposed is based on the principle that:

- Power supplies of consumer appliances are asymmetrical sources of disturbance for which an AMN (V-network) is suited to determine the interference potential.
- In contrast telecommunication devices, including PLT modems, are engineered to be symmetrical sources. Thus, the common mode current, which is agreed as representative of the potential interference, mainly results from the conversion of the differential current in the connected network. The difference from fed differential mode to common mode is the conversion factor which depends on the symmetry of the connected network.
- The AMN is suitable to measure the so called unsymmetrical voltage generated by the EUT. It does not measure the common mode signal generated by conversion in the connected network. With a symmetric EUT, the method using an AMN simply measures half of the differential mode voltage.
- A T-ISN has to be used.
- The 25 Ω common mode impedance of the T-ISN was selected to be equal to the common mode impedance of the AMN.
- The test setup with the T-ISN is similar to the present CISPR 22 test setup for the compliance test of telecommunication ports.
- From 1,605 MHz to 30 MHz, the PLT ports are tested twice: the T-ISN is used for conformance testing when the telecommunication function is active and the AMN is used for conformance testing when the telecommunication function is inactive.
- From 150 kHz to 1,605 MHz, the PLT ports are tested using an AMN since the PLT devices are not expected to generate any "wanted signal" in that frequency band for telecommunication on the power lines.

The voltage limits proposed in this CD are the voltage limits applying to the mains ports, according to CISPR 22 (Table 1 and 2). The current limits proposed between 1,605 MHz and 30 MHz are derived for use with the new impedance stabilization network (ISN) which presents a common mode (asymmetric mode) impedance of 25 Ω to the PLT port under test (conversion factor is $20 \log_{10}(25 \Omega) = 28$ dB).

The Longitudinal Conversion Loss (LCL) value of 24 dB chosen for the T-ISN is the converging result of two independent approaches.

- The project team analyzed about 600 measurements of LCL of existing power lines in 6 different countries. No major differences were noted between the results from the different countries.
- The second approach, called the “symmetry decoupling method” consisted in comparing the disturbance on a dummy radio caused by the injection on power lines of asymmetrical signals on one hand and symmetrical signals on the other hand. The measurements confirmed that a symmetrical source causes much less disturbance on the dummy radio than an asymmetrical source adjusted at the same level of injection. The LCL of the T-ISN is determined in such a way that two sources, a symmetrical one measured using the T-ISN and an asymmetrical one measured using an AMN, and meeting the same limits cause comparable interference on the dummy radio.

2. Proposal for amendment to CISPR 22, Edition 5.2

The editing instructions are shown in red italic. Three editing instructions are used: change, add and renumber. Changes are described by using ~~strike through~~ (to remove old material) or underscore (to add new material).

Add new clause 3.12 to read as follows:

3.12 PLT port

A port connecting to power lines supporting data transfer and telecommunications.

Change the headline of clause 5 to read as follows:

5 Limits for conducted disturbance at mains ports, PLT ports and telecommunication ports

Change 1st paragraph of clause 5 to read as follows:

The equipment under test (EUT) shall meet the limits in tables 1 and 3 or 2 and 4 or 3 and 5 or 4 and 6, as applicable, ... Either the voltage limits of the currents limits of Table 3 ~~or 4, 5 or 6~~, as applicable, shall be met except for the measurement method of C.1.3 where both limits shall be met.

Add the following clause 5.3 to read as follows:

5.3 Limits of disturbance at PLT ports

From 0,15 MHz to 1,605 MHz, the PLT ports of the EUT shall meet the limits in tables 1 or 2 of 5.1 as applicable.

From 1,605 MHz to 30 MHz, the PLT ports of the EUT shall meet the limits in tables 5 or 6 as applicable when the telecommunication function is active and shall meet the limits in tables 1 or 2 of 5.1 as applicable when the telecommunication function is inactive.

Table 5 – Limits of conducted common mode (asymmetric mode) disturbance at PLT ports in the frequency range 1605 kHz to 30 MHz with the telecommunication function active for Class A equipment

Frequency range MHz	Voltage limits dB(µV)		Current limits dB(µA)	
	Quasi-peak	Average	Quasi-peak	Average
1,605 to 30	73	60	45	32
NOTE 1 The lower limit shall apply at the transition frequencies.				
NOTE 2 The current and voltage disturbance limits are derived for use with an impedance stabilization network (ISN) which presents a common mode (asymmetric mode) impedance of 25 Ω to the PLT port under test. (conversion factor is $20 \log_{10} 25 \Omega = 28 \text{ dB}$)				

Table 6 – Limits of conducted common mode (asymmetric mode) disturbance at PLT ports in the frequency range 1605 kHz to 30 MHz with the telecommunication function active for Class B equipment

Frequency range MHz	Voltage limits dB(μV)		Current limits dB(μA)	
	Quasi-peak	Average	Quasi-peak	Average
1,605 to 5	56	46	28	18
5 to 30	60	50	32	22

NOTE 1 The lower limit shall apply at the transition frequencies.

NOTE 2 The current and voltage disturbance limits are derived for use with an impedance stabilization network (ISN) which presents a common mode (asymmetric mode) impedance of 25 Ω to the PLT port under test. (conversion factor is $20 \log_{10} 25 \Omega = 28 \text{ dB}$)

In clause 6, renumber “Table 5 Limits for radiated disturbance of class A ITE at a measuring distance of 10 m” to:

“Table 7 Limits for radiated disturbance of class A ITE at a measuring distance of 10 m”

In clause 6, renumber “Table 6 Limits for radiated disturbance of class B ITE at a measuring distance of 10 m” to:

“Table 8 Limits for radiated disturbance of class B ITE at a measuring distance of 10 m”

Change the headline of clause 9 to read as follows:

9 Method of measurement of conducted disturbance at mains terminals, telecommunication ports and PLT ports

Change 1st paragraph of clause 9.5.1 to read as follows:

The mains cable of the unit being measured shall be connected to one artificial mains network (AMN), except when the mains cable connects to a PLT port, then the AMN shall be used only for frequencies between 150 and 1605 kHz and when the telecommunication function is inactive for frequencies between 1605 kHz and 30 MHz. Where the EUT is a system, which.....

Change 6th paragraph of clause 9.5.1 to read as follows:

All telecommunication, PLT and signal ports must be.....

Change 7th paragraph of clause 9.5.1 to read as follows:

If ISNs are used for measurements on telecom ports or on PLT ports for frequencies between 1,605 and 30 MHz when the telecommunication function is active, they shall....

Add to clause 9.5.2, end of the last paragraph, the sentence:

If PLT devices with integrated mains coupler are used and for compliance tests at frequencies between 1605 kHz and 30 MHz , the mains cable from the PLT port shall be connected to an ISN specified in 9.7.2 when the telecommunication function is active, and not to an AMN.

Add to clause 9.5.3, end of the 2nd paragraph, the sentence:

If PLT devices with integrated mains coupler are used and for compliance tests at frequencies between 1605 kHz and 30 MHz, the mains cable from the PLT port shall be connected to an ISN specified in 9.7.2 when the telecommunication function is active, and not to an AMN.

Add to clause 9.5.4, end of the 2nd paragraph, the sentence:

If PLT devices with integrated mains coupler are used and for compliance tests at frequencies between 1605 kHz and 30 MHz, the mains cable from the PLT port shall be connected to an ISN specified in 9.7.2 when the telecommunication function is active, and not to an AMN.

Add a new clause 9.7 to read as follows:

9.7 Measurement of disturbances at PLT ports

9.7.1 Methods of conformance testing

For frequencies between 1605 kHz and 30 MHz, the PLT ports of the EUT shall be measured twice: the manufacturer shall demonstrate that the equipment does not exceed the limits of Tables 5 or 6 when tested with an ISN in accordance with 9.7.2 when the telecommunication function is active and does not exceed the limits of Tables 1 or 2 when tested with an AMN in accordance with 9.3 when the telecommunication function is inactive.

For frequencies between 150 kHz and 1605 kHz the manufacturer shall demonstrate that the equipment does not exceed the limits of Tables 1 or 2 when tested with an AMN in accordance with 9.3.

9.7.2 Impedance stabilization network (ISN)

The mains voltage shall be supplied to the EUT via the ISN.

The current probe, if used, shall be mounted on the cable within 0.1 m distance of the ISN. The insertion impedance of the current probe must be 1 Ω maximum, see 5.1 of CISPR 16-1-2

The ISN (calibrated including any and all adapters required to connect to the EUT, the Coupling System and the AE) shall have the following properties in the frequency range of 1,605 MHz to 30 MHz :

- a) The common mode termination impedance shall be 25 Ω +/- 3 Ω , phase angle 0° +/- 25°,
- b) The differential mode termination impedance shall be 100 Ω +/- 10 Ω , phase angle 0° +/- 25°,
- c) The differential mode transmission loss of the ISN (excluding the Coupling System) shall be $a_{DISN} = 20 \log (E_D / (2 * V_{DISN})) \leq 3$ dB (The measurement set-up is shown in Figure H.1)
- d) The common mode transmission loss of the ISN (excluding the Coupling System) between the AE port and the measurement port shall be $a_{CISN} = 20 \log (E_{CISN} / (2 * V_{CISN})) > 14$ dB (The measurement set-up is shown in Figure H.2)
- e) The longitudinal conversion loss (LCL) of the ISN input (EUT side) shall be 24 dB +/- 1 dB
- f) The attenuation distortion or other deterioration of the signal quality in the wanted signal frequency band caused by the presence of the ISN shall not affect the normal operation of the EUT.
- g) If a voltage port on the ISN is available then the accuracy of the voltage division factor shall be within $\pm 1,0$ dB of the nominal value (of - 1 dB for LCL = 24 dB). The voltage division factor is the difference between the voltage appearing across the common mode impedance

presented to the EUT by the ISN and the resulting voltage appearing across a receiver input attached to the measuring port of the ISN, expressed in decibels

- h) The attenuation of the Coupling System in conjunction with the ISN, for common mode current or voltage disturbances originating from the AE or from the mains, shall be such that the measured level of these disturbances at the measuring receiver input shall be at least 10 dB below the relevant disturbance limit. The following attenuations are recommended:

The differential mode transmission loss of the Coupling System should be
 $a_{DCS} = 20 \log (E_{DCS} / (2 * V_{DCS})) > 40 \text{ dB} \pm 6 \text{ dB}$; (The measurement set-up is shown in Figure H.3)

The common mode transmission loss of the coupling System should be
 $a_{CCS} = 20 \log (E_C / (2 * V_{CCS})) > 40 \text{ dB}$; (The measurement set-up is shown in Figure H.4)

*Renumber clause "9.7 Recording of measurements" to:
"9.8 Recording of measurements"*

Change the first paragraph of Annex B to read as follows:

If using a peak measuring receiver to reduce the testing time when performing conducted disturbance measurements at the mains or the telecommunication ports or the PLT ports in the frequency range...

Add to clause C.1.1, end of the first paragraph, the sentence:

For PLT port measurements the ISN according to 9.7.2 shall be used when the telecommunication function is active.

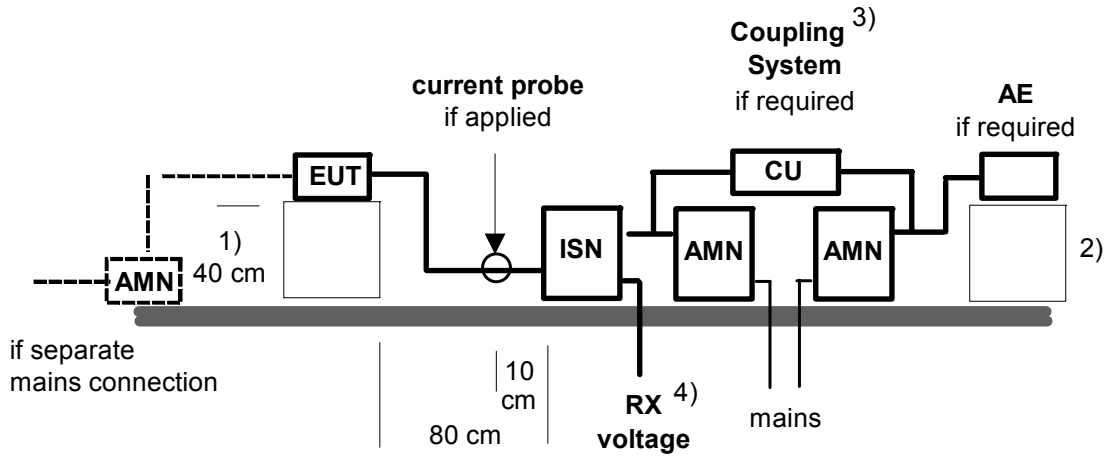
Add clause C.1.5 to section C.1 of Annex C, to read as follows:

C.1.5 . Test set up for measuring the common mode disturbance at PLT ports

The method in C.1.5 shall be used for PLT port conformance tests, the telecommunication function being activated.

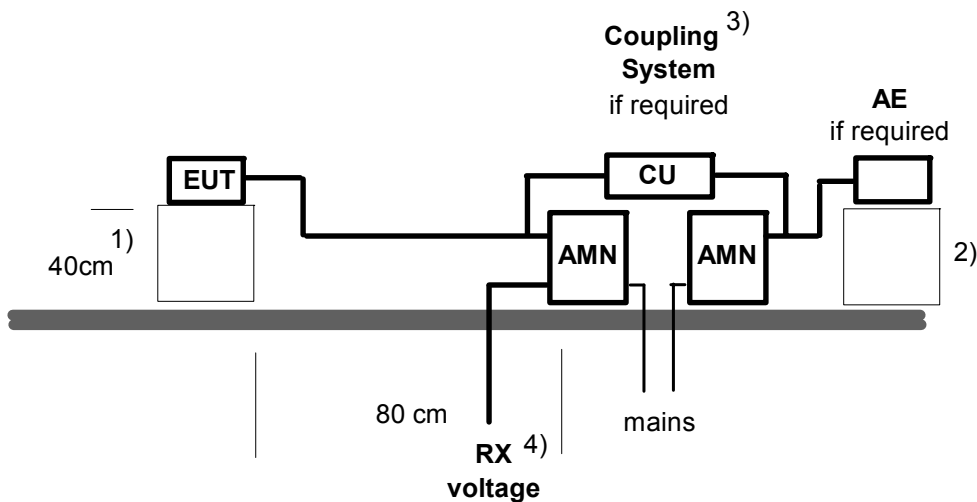
- Connect ISN directly to reference ground plane.
- If voltage measurement is used, measure voltage at the RX voltage port of the ISN, correct the reading by adding the ISN voltage division factor defined in 9.7.2
- It is not necessary to apply the voltage and the current limit if an ISN is used. A 50 Ω load has to be connected to the RX voltage port of the ISN during the current measurement.

Add Figures C.5; C.6; and C.7 to look as follows:



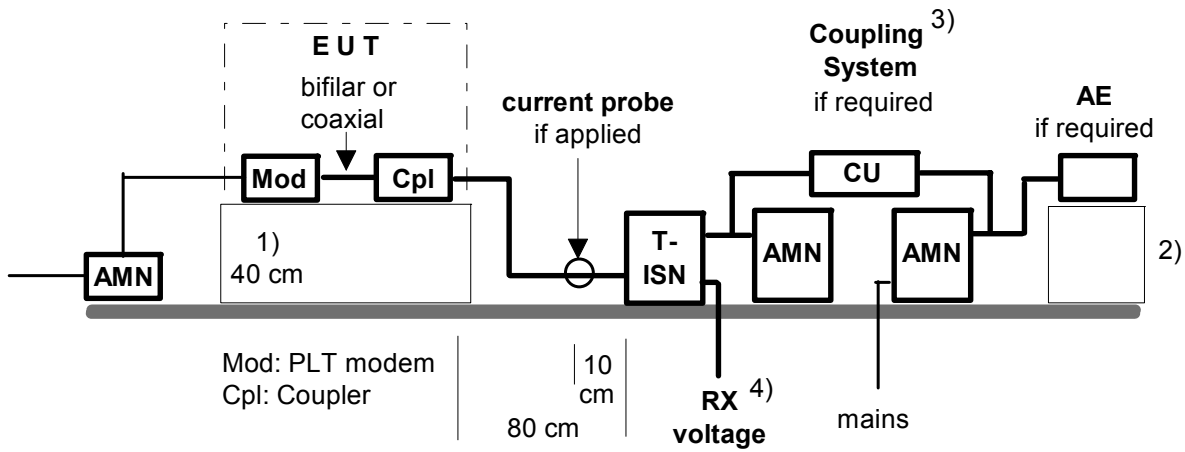
- 1) Distance to the reference ground plane (vertical or horizontal)
- 2) Distance to the reference ground plane is not critical
- 3) Functions of the Coupling set-up:
 - stabilization of the differential mode impedance
 - isolation of the differential- and common mode signal of the AE
 - filtering of the differential- and common mode signal from the mains
- 4) ISN voltage for 1605 kHz and 30 MHz (if applied)

Figure C.5: Compliance test set-up for 1605 kHz to 30 MHz when the telecommunication function is active



- 1) Distance to the reference ground plane (vertical or horizontal)
- 2) Distance to the reference ground plane is not critical
- 3) Functions of the Coupling set-up:
 - stabilization of the differential mode impedance
 - isolation of the differential- and common mode signal of the AE
 - filtering of the differential- and common mode signal from the mains
- 4) AMN voltage

Figure C.6: Compliance test set-up for PLT for 150 kHz to 1605 kHz



- 1) Distance to the reference ground plane (vertical or horizontal)
- 2) Distance to the reference ground plane is not critical
- 3) Functions of the Coupling set-up:
 - stabilization of the differential mode impedance
 - isolation of the differential- and common mode signal of the AE
 - filtering of the differential- and common mode signal from the mains
- 4) ISN voltage for 1605 kHz and 30 MHz (if applied)

Figure C.7: Compliance test set-up for PLT devices with separate coupler for 1605 kHz to 30 MHz when the telecommunication function is active

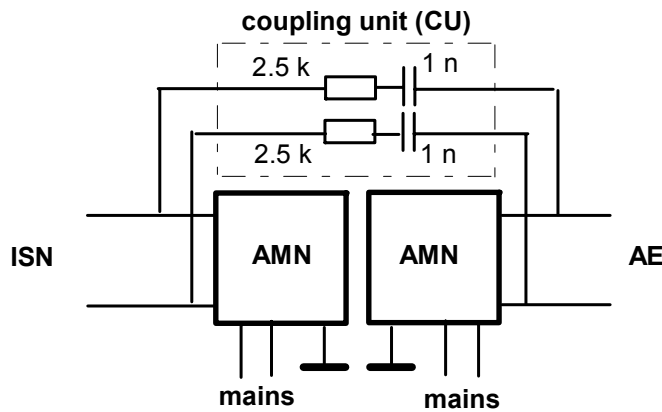
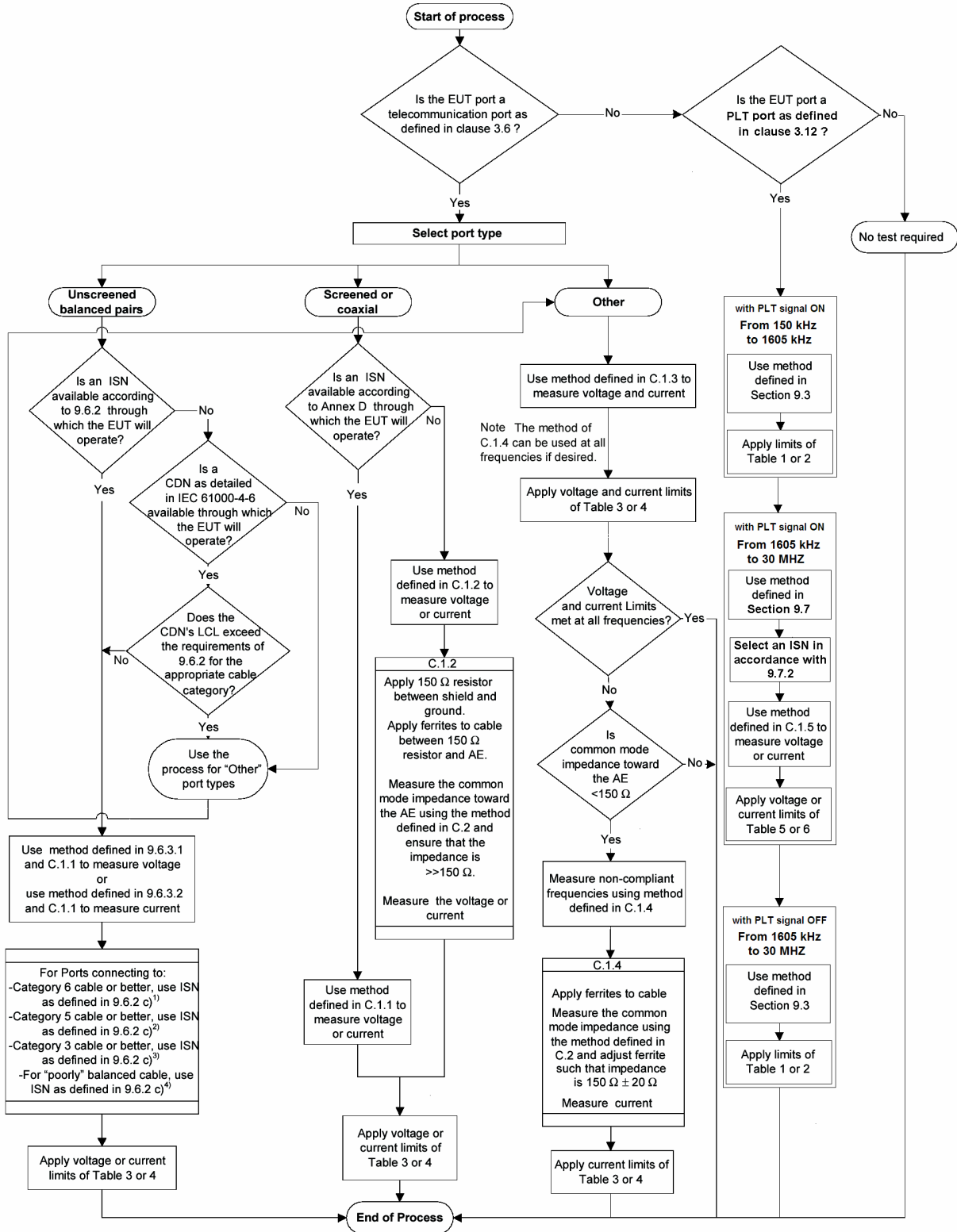


Figure C.8: Coupling System to mains and AE

Renumber "Figure C.5 - Calibration fixture" to:
 "Figure C.9 - Calibration fixture"

Renumber "Figure C.6 - flowchart for selecting test method" to:
 "Figure C.10 - flowchart for selecting test method"

Change "Figure C.10 - flowchart for selecting test method" to look as follow:



Add new Annex H which reads as follows:

**Annex H
(informative)**

**Measurement set-ups for the characterization of
ISN and Coupling System to be used for
compliance testing of PLT devices when the telecommunication function is active**

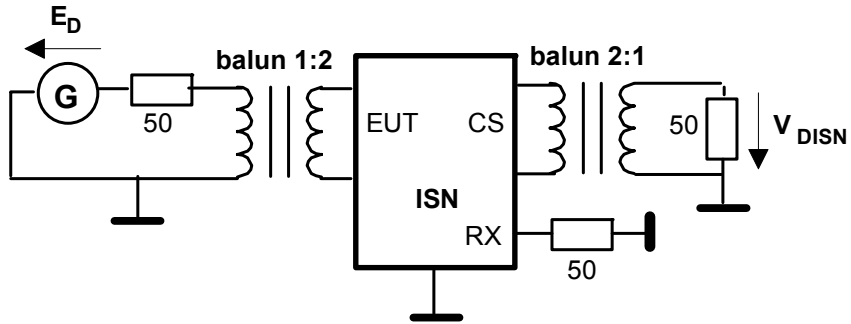


Figure H.1 Differential mode ISN transmission loss measurement set-up

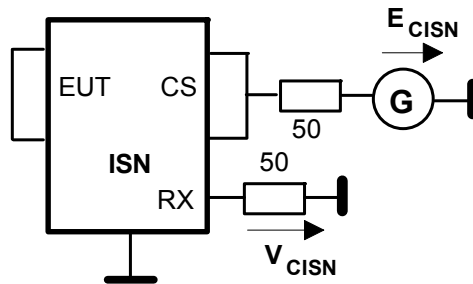


Figure H.2 Common mode ISN transmission loss measurement set-up

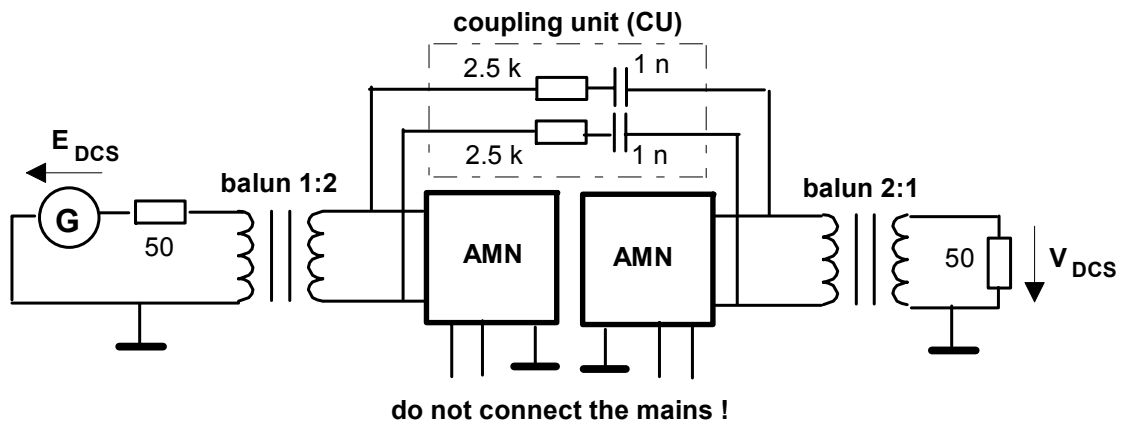


Figure H.3 Differential mode Coupling System transmission loss measurement set-up

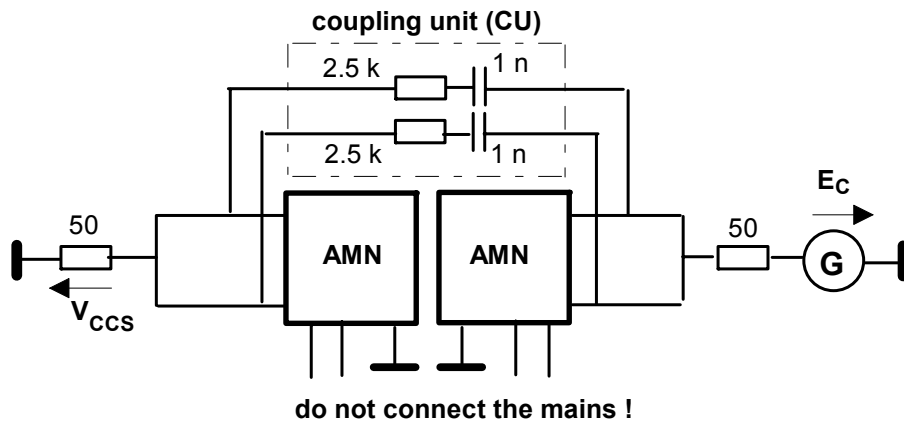


Figure H.4 Common mode Coupling System transmission loss measurement set-ups

Add new Annex I which reads as follows:

**Annex I
(informative)**

Rationale for disturbance measurements and methods on PLT ports

The basic assumption in CISPR 22 for measurements on the connections to the low voltage distribution network is that the interface to the EUT can be described by an artificial mains network (AMN) in accordance with CISPR 16-1. Seen from either the L- or the N-connection of the EUT, the AMN shows an impedance of $50\ \Omega$ to earth. This amounts to a differential mode impedance of $100\ \Omega$ and a common mode impedance of $25\ \Omega$. In principle the AMN is a symmetric circuit, but the specification for symmetry is rather loose. The voltage measured at the AMN is the voltage between one of the conductors to the EUT and the earth, i.e. the voltage across one of the $50\ \Omega$ impedances. With the AMN one measures both, the unsymmetrical component of the perturbation emitted by the EUT and half of the symmetric component. The AMN shows a high decoupling between the port to the EUT and port to the low voltage distribution network.

The AMN is not suitable for measurements on PLT ports with activated telecommunication functions.

First, the mains port measurement method with the AMN was designed with EUTs in mind that are primarily asymmetric sources of perturbations, where the common mode component is dominant. (It is relatively easy to attenuate the symmetric component by means of EMC capacitors). It is generally accepted that the common mode component is the main cause of interference to radio reception.

In contrast PLT ports are engineered to be symmetrical sources, as are telecommunication ports. Thus, the common mode component emitted by the EUT is strongly reduced. The common mode current, which is the dominant cause for interference to radio reception, mainly results from the conversion of the differential current in the connected network. Measurements with the AMN do not take this effect into account, thus they are not representative of the interference potential of PLT ports.

The ISN defined in Clause 9.7.2 is a circuit which allows the measurement of the common mode component with the same common mode and differential mode impedance as the AMN. With a defined asymmetry (LCL), the ISN provides an appropriate and reliable method to weight the interference risk of the symmetrical component at the PLT ports, as the ISN defined in Clause 9.6.2 does with telecommunication ports.

In addition, there is no connection to the AE. If the AE is connected in parallel to the low voltage distribution network its proper function is not assured, because of the high isolation between the two ports of the AMN. Of course it is not admissible to connect the AE in parallel to the EUT because it may then strongly influence measured voltage.