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BSI Standards Publication

Power line communication apparatus used in low-voltage installations — Radio disturbance characteristics — Limits and methods of measurement

Part 3: Apparatus operating above 30 MHz

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National foreword

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English Version

Power line communication apparatus used in low-voltage installations - Radio disturbance characteristics - Limits and methods of measurement - Part 3: Apparatus operating above 30 MHz

Appareils de communication par courant porteur utilisés dans les installations basse tension - Caractéristiques de perturbations radioélectriques - Limites et méthodes de mesure - Partie 3 : Appareils fonctionnant au-dessus de 30 MHz

Kommunikationsgeräte auf elektrischen Niederspannungsnetzen - Funkstöreigenschaften - Grenzwerte und Messverfahren - Teil 3: Geräte für Frequenzen über 30 MHz

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Europäisches Komitee für Elektrotechnische Normung

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Contents

European foreword

This document (EN 50561-3:2016) has been prepared by CLC/TC 210, “Electromagnetic compatibility (EMC)”.

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2016-11-23
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2018-11-23

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For the relationship with EU Directive(s) see informative Annex ZZ, which is an integral part of this document.

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 ensure that the electromagnetic disturbance generated does not exceed the level above which radio and telecommunications equipment or other equipment cannot operate as intended.

1 Scope

This part of EN 50561 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 part of EN 50561 applies to equipment that uses frequencies including those above 30 MHz in order to communicate.

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

The radiated emission requirements in this standard are not intended to be applicable to the intentional transmissions from a radio-transmitter as defined by the ITU, nor to any spurious emissions related to these intentional transmissions.

NOTE The requirements defined in this standard effectively restrict the intended transmission frequencies to below 87,5 MHz.

2 Normative references

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

EN 50561-1:2013, *Power line communication apparatus used in low-voltage installations — Radio disturbance characteristics — Limits and methods of measurement — Part 1: Apparatus for in-home use*

EN 55032:2012, *Electromagnetic compatibility of multimedia equipment — Emission requirements (CISPR 32:2012)*

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 55016-4-2:2011, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 4-2: Uncertainties, statistics and limit modelling — Measurement instrumentation uncertainty (CISPR 16-4-2:2011)*

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 PLC Measurement Network
APMN
measurement network which provides a defined impedance at high frequencies across the power feed at the point of measurement of the terminal voltage, and also providing isolation of the circuit under test from the ambient noise on the power lines. The network also provides a defined coupling path between EUT and AE

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 1 to entry: 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
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

3.7
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 information transfer;

b) with a rated supply voltage not exceeding 600 V

Note 1 to entry: ITE includes, for example, data processing equipment, office machines, electronic business equipment and telecommunication equipment.

3.8
PLC apparatus
apparatus with a PLC port

Note 1 to entry: PLC apparatus are also called PLT apparatus

3.9
PLC port
port for the purpose of data transfer and communications that may also carry electrical energy to or from the EUT

Note 1 to entry: PLC ports are also called PLT ports

3.10
user data
data originated from or destined to another device

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 to entry: 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 to entry: A PLC port is not considered a telecommunications network port in the sense of this definition.

4 Compliance with this standard

Equipment compliant with this standard shall exclusively transmit signals between phases or between phase and neutral and shall not intentionally transmit PLC signals at frequencies higher than 87,5 MHz.

5 Requirements for the frequency range below 30 MHz

5.1 Requirement for conducted disturbances at AC mains power port

The AC mains power port of the EUT shall comply with the class B limits of EN 55032, using the measurement conditions and the methodology defined in EN 55032 for mains terminals.

5.2 Requirement for conducted disturbances at telecommunication/network port

The telecommunications/network port of the EUT shall comply with the class B limits of EN 55032, using the measurement conditions and methodology defined in EN 55032 for wired network ports.

5.3 Requirement for conducted disturbances and communications signals at PLC ports

The methods and limits for conducted measurements of EN 50561-1 apply for PLC apparatus for measurement frequencies 30 MHz and below.

6 Requirement for the frequency range above 30 MHz

6.1 Requirement for conducted disturbances and communications signals for frequencies between 30 MHz and 87,5 MHz

When user data are being transmitted by the PLC port at frequencies between 30 and 87,5 MHz the unsymmetrical voltage of the transmitted signal shall not exceed the limits given in Table 1 using the methods and procedures given in 7.2, with the exception of the frequency bands listed in Table A.1 for which the limits for the unsymmetrical disturbances specified in Table 2 apply.

Unless otherwise noticed, limits are given in dB(µV) (PK) in a 120 kHz bandwidth.

Table 1 — Maximum unsymmetrical PLC transmit signal level injected between two phases or between phase and neutral conductors between 30 MHz and 87,5 MHz except for the frequency bands listed in Table A.1

Maximum unsymmetrical voltages of the transmitted signal from 30 MHz to 80 MHz, in dB(µV) (PK)	**85 at 30 MHz, decreasing to 80 at 80 MHz (see note 3)**
Maximum unsymmetrical voltages of the transmitted signal from 80 MHz to 87,5 MHz in dB(µV) (PK)	**80 at 80 MHz decreasing to 60 at 87,5 MHz (see note 4)**
NOTE 1: The Voltage Division Factor of the Coupling device has to be taken into account. NOTE 2: The maximum symmetrical voltage is 6 dB above the maximum unsymmetrical voltage. NOTE 3: The limit decreases linearly with frequency in the range 30 MHz to 80 MHz NOTE 4: The limit decreases linearly with frequency in the range 80 MHz to 87,5 MHz	

Table 2 — Maximum conducted unsymmetrical disturbance signal level in the frequency bands listed in Table A.1 for services requiring increased protection

Maximum unsymmetrical voltages of the transmitted signal in dB(µV) (PK)	**55**
NOTE 1: The Voltage Division Factor of the Coupling device has to be taken into account. NOTE 2: The maximum symmetrical voltage is 6 dB above the maximum unsymmetrical voltage.	

6.2 Requirement for conducted disturbances for frequencies between 87,5 MHz and 118 MHz

The unsymmetrical disturbances from the PLC port when transmitting user data shall comply with the disturbance limits between 87,5 MHz and 118 MHz given in Table 3.

Table 3 — Maximum conducted unsymmetrical disturbance signal level

Maximum unsymmetrical voltages of the transmitted signal from 87,5 MHz to 108 MHz, in dB(µV) (PK)	**60**

Maximum unsymmetrical voltages of the transmitted signal from 108 MHz to 118 MHz, in dB(µV) (PK)	**55**
NOTE 1: The Voltage Division Factor of the Coupling device has to be taken into account. NOTE 2: The maximum symmetrical voltage is 6 dB above the maximum unsymmetrical voltage.	

Limits set by requirements 6.1 and 6.2 are illustrated in Figure 1.

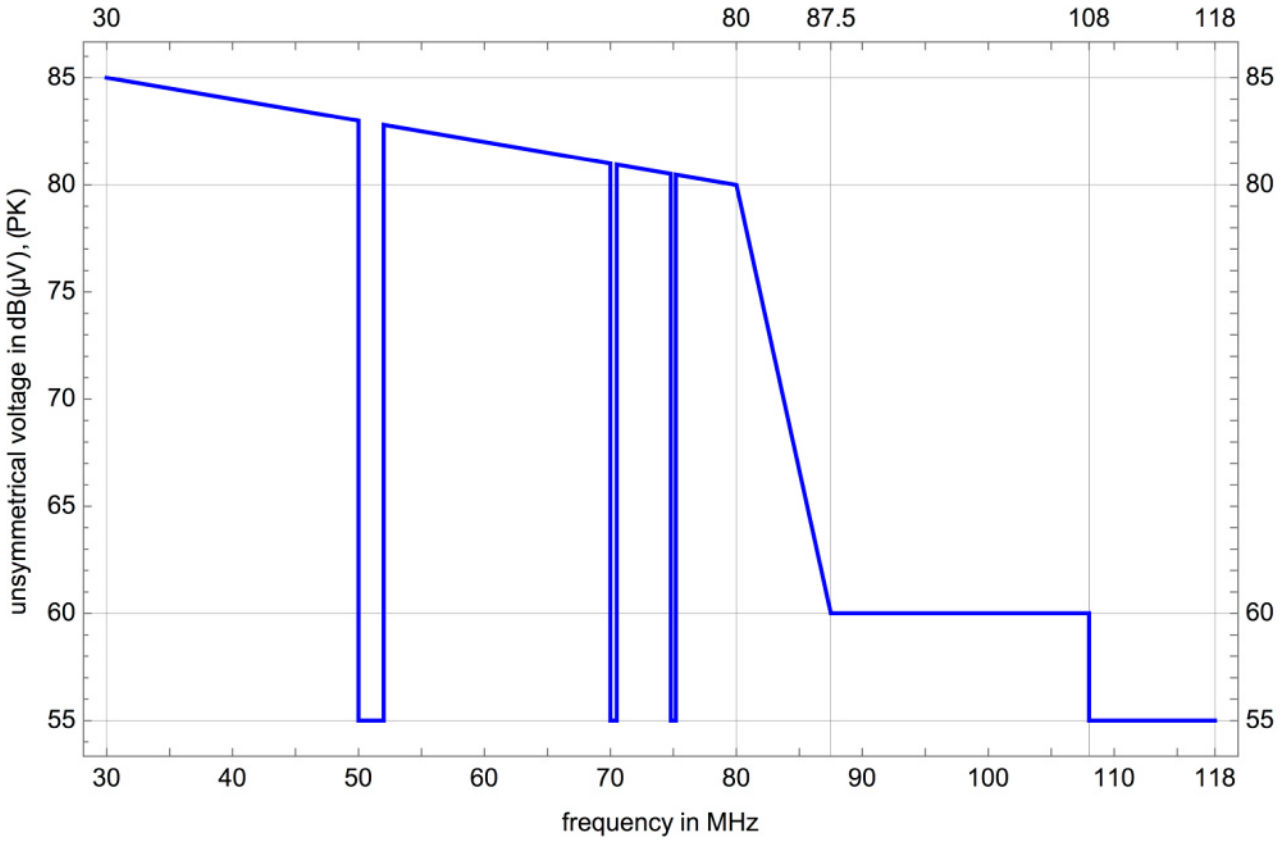

Figure 1 — Maximum conducted disturbance signal level for frequencies between 30 and 118 MHz

6.3 Requirement for radiated disturbances for frequencies above 30 MHz

For all operating states the EUT shall comply with the class B limits for measurement conditions and methodology defined in EN 55032 for radiated disturbances

7 Measurement conditions for PLC ports

7.1 Operation conditions

The measurements of PLC ports shall be performed in conformance with EN 55032:2012, Annex B, Table B.3.

To perform the tests requiring user data transmission through the PLC port, the following procedure shall apply:

- Determine the maximum possible data rate between the PLC ports of the EUT and AE in the test setup.

- Exercise the EUT PLC port to transmit user data at a rate in excess of 10 % of the maximal possible data rate determined for the setup.

- As an example the transmission of a large data file or a software tool which creates arbitrary data streams could be used to exercise the port.

For EUT with an AC mains output port, no device shall be connected to this port during testing.

7.2 Unsymmetrical conducted emission measurements between 30 and 118 MHz

The symmetrically transmitted signals from the PLC port of the EUT shall be measured for frequencies between 30 and 118 MHz in order to ensure the maximum transmit signal levels are not exceeded. The PLC port shall be exercised in accordance with the operating conditions given in 7.1. Measurements shall be made using a Peak detector in accordance to the requirements of EN 55016-1-1 including the 120 kHz requirement for the 6 dB bandwidth.

An example of a test arrangement, which avoids the use of a balun, is given in Annex B. In this arrangement the two unsymmetrical voltages U_{Line1} and U_{Line2} shall be measured and compared with the limit values given in Tables 1, 2 and 3. In a symmetrical system they are of equal magnitude and of opposite phase. Each of them represents half of the total symmetrically transmitted signal.

Measurements according to 6.1 to 6.3 inclusive shall all be performed with a symmetrical insertion loss between EUT and AE of 40 dB.

8 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

Table A.1 — Permanently excluded frequency ranges between 30 MHz and 87,5 MHz

Excluded frequency range (MHz)	Service
50 – 52	**Amateur Radio Service**
70 – 70,5	**Amateur Radio Service**
74,8 – 75,2	**Aeronautical Radio Navigation**

NOTE Frequencies have been selected to ensure operation of radio equipment that is expected to be in the same environment, additional frequency exclusions might be required in some countries (police/fire brigade/safety services)

Annex B
(normative)

Example of test arrangement

The measurement of conducted emission of mains-powered devices in EMC is usually performed by an electric network (AMN: Artificial Mains Network as defined in EN 55016-1-2), which shall provide electrical conditions that shall compare to those that can be found on the mains network. The before mentioned AMN is not suitable in the scope of this standard, because it is only defined to work up to 30 MHz measurement frequency and it provides a low pass behaviour from the supply grid to the equipment under test, which can badly influence a PLC test setup (with working frequencies above 30 MHz).

For the assessment of the injected signal of a PLC modem into the mains grid a new network had to be defined. The unsymmetrical voltage of phase and neutral conductor to reference ground shall be assessed. The following characteristics shall be met:

- It shall provide a measurement port for the phase and neutral conductor for frequencies between 30 MHz and 118 MHz originating from the EUT-port

- It shall provide a bidirectional, flat-attenuated high frequency path for the differential PLC-signal (between phase and neutral conductor) from the EUT modem to the AE modem with a nominal attenuation of 40 dB ± 4 dB. This attenuation shall be met for frequencies between 1,6 MHz to 87,5 MHz

- The common mode impedance for phase or neutral conductor to the reference ground at the EUT port shall be Z_{CM} = 50 Ω +30 %/-10 % for frequencies between 30 MHz and 118 MHz

- The differential mode impedance between phase and neutral conductor at the EUT port shall be Z_{DM} = 100 Ω ± 20 % for frequencies between 30 MHz and 87,5 MHz

- It shall provide sufficient decoupling for high frequencies from and to the supply grid for the EUT-modem port and the AE-modem port for both the differential and the common mode signals, so that the measurement is not affected by any mains noise. Alternatively AMNs can be used to power this ISN and provide the filtering of the mains disturbances.

Figure B.1 shows a possible example network. In each branch there are two 20 dB π-attenuators in series.

The attenuators on the EUT-side contain a 50 Ω coaxial port for the measurement of the unsymmetrical signals. The 50 Ω impedance of the test equipment (or termination) forms part of the left shunt impedance of the attenuators (R1 + 50 Ω = R2 = R9 = R10). The inductors L1 to L4 provide a high impedance path to the filtered mains supply for frequencies in the range from 1 MHz to 118 MHz.

NOTE 1 In order to achieve sufficiently high impedance over the whole frequency range, inductors L1 to L4 may be each made up of several inductors (with different self-resonant frequencies) in series.

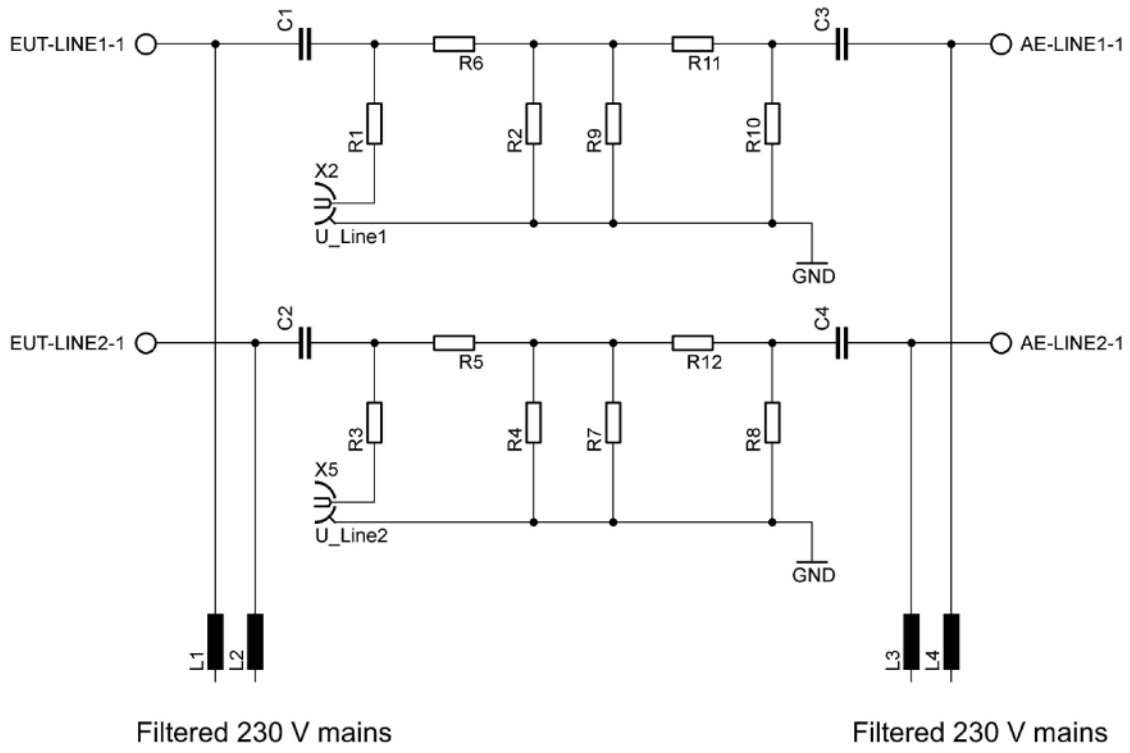

Figure B.1 — Example of a test arrangement for measuring the conducted unsymmetrical voltages of the transmitted PLC signal with example of coupling device

NOTE 2 The Voltage Division Factor as defined in EN 55016–1-2 of this Coupling device: 20*log (50 / 96,3) = - 5,7 dB

In case only one receiver (RX) is used at a time, the unused interface shall be terminated with 50 Ω.

Annex C
(informative)

Rationale for the use of conducted and radiated measurement methods

In-home PLC apparatus use the mains-electricity wiring in the home for communication by injecting differential-mode (DM) signals. However these signals have the potential to cause interference to the operation of radio or telecommunication apparatus. To control this situation both radiated-emissions and conducted-emissions tests are specified, and both are necessary as they control different things.

Crosstalk into telecommunication cables can arise when they run to some degree in proximity to mains wiring on which PLC signals are present. Conducted-emissions tests which control the DM injected signals are an appropriate way to do this.

Interference to radio reception can arise if excessive radiated emissions reach the antenna of the receiver. Radiated emissions may in general be controlled by either radiated or conducted measurements, but both have their place in the specific circumstances of this standard.

EMC assessment of PLC equipment for frequencies below 30 MHz is performed by conducted measurements of signals from the PLC port as defined in EN 50561-1. These tests implement a limitation of the injected energy from a PLC device into the mains network for frequencies below 30 MHz, and thereby limit the emissions consequently radiated by the domestic mains wiring in the home where the PLC apparatus is used.

The remainder of this discussion concerns frequencies above 30 MHz.

General EMC assessment above 30 MHz is done by radiated measurements according to EN 55022 or EN 55032 methodology. The radiation which this approach controls comprises two components:

— radiation from the EUT itself (cabinet radiation);

— radiation from the cables connected to the EUT in the test arrangement, arising because common-mode (CM) currents flow on them.

However, in practical use of PLC apparatus in the home, radiation also arises from other parts of the home mains wiring than simply the apparatus cable. This is caused because the deliberately-injected DM excites currents to flow *inter alia* on stubs, or on L and N wires which are physically separated because they form part of a 2-way switched lighting circuit. Such effects have no analogy in the controlled circumstances of the radiated-emissions test in which the only radiation from wiring occurs because some CM is induced to flow on the apparatus cable by mode conversion, or because the EUT generates CM in its own right.

The radiated measurement technique of EN 55022 or EN 55032 has not been found to be a consistent way to control the deliberate injection of DM by an EUT, owing to large variability between results in different test laboratories. These arise partly from different layouts but largely from differences in the high frequency termination of 230 V AC supply lines and Ethernet cables. These terminations might be decoupling by a ferrite clamp (CMAD), by a coupling device network (CDN) or just undefined, routed to a filter at the enclosure’s entry points. Simply put, using a test in which DM is controlled by measuring radiation resulting from induced CM, when the conversion of DM to CM by the test jig is uncontrolled and may in extremis be quite negligible, is not satisfactory.

For that reason, this standard applies conducted measurements in the frequency range 30 MHz to 118 MHz in order to control directly the deliberate DM injection of PLC signals within and slightly beyond their operating band. This protects both telecommunication apparatus and radio receivers from excessive interference.

The radiated measurements of EN 55022 or EN 55032 are applied additionally over their customary full frequency range in order to:

— provide continuity with existing assessments

— control any cabinet radiation that may happen (Although PLC apparatus like modems or routers usually has small dimensions compared to the wavelengths in the 30MHz to 118MHz range, so such radiation is then unlikely to be significant, PLC functionality may also be incorporated in devices which are physically larger and could have greater propensity to radiate. To treat all apparatus fairly, all should therefore be tested.)

— control any CM emissions that the EUT may produce

It follows that both the radiated and conducted tests are necessary: the conducted tests control the deliberate DM injection while the radiated tests control everything else.

Annex ZZ
(informative)

Relationship between this European standard and the essential requirements of Directive 2004/108/EC and Directive 1999/5/EC

This European Standard has been prepared under mandate M/313 to provide one voluntary means of conforming to essential requirements of Directive 2004/108/EC and Directive 1999/5/EC.

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of this standard given in Table ZZ.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

Table ZZ.1 — Correspondence between this European Standard and relevant Directives

Essential Requirements of Directive 2004/108/EC	Essential Requirements of Directive 1999/5/EC	Clauses and sub-clauses of this EN
Annex 1, Article 1(a) – Protection requirements (electromagnetic disturbances	Article 3.1(b) - Protection requirements with respect to electromagnetic compatibility (disturbances)	5.1 Requirement for conducted disturbances at AC mains power port
Annex 1, Article 1(a) – Protection requirements (electromagnetic disturbances	Article 3.1(b) - Protection requirements with respect to electromagnetic compatibility (disturbances)	5.2 Requirement for conducted disturbances at telecommu-nication/network port
Annex 1, Article 1(a) – Protection requirements (electromagnetic disturbances	Article 3.1(b) - Protection requirements with respect to electromagnetic compatibility (disturbances)	5.3 Requirement for conducted disturbances and communica-tions signals at PLC ports
Annex 1, Article 1(a) – Protection requirements (electromagnetic disturbances	Article 3.1(b) - Protection requirements with respect to electromagnetic compatibility (disturbances)	6.1 Requirement for conducted disturbances and commu-nications signals for frequencies between 30 MHz and 87,5 MHz
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Annex 1, Article 1(a) – Protection requirements (electromagnetic disturbances)	Article 3.1(b) - Protection requirements with respect to electromagnetic compatibility (disturbances)	6.3 Requirement for radiated disturbances for frequencies above 30 MHz

WARNING 1: Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of

this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2: Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

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