Chapter 4 – LIMITS FOR WIRE-LINE TRANSMISSION SYSTEMS

HF radio services may be affected by unwanted radiation from the new broadband wire-line telecommunication networks. To fulfil the protection requirements described in Section 2.4, emission limits for these wire-line telecommunication networks have to be introduced.

4.1 EXISTING STANDARDS AND REGULATIONS

CISPR 22 is an international standard produced by CISPR (International Special Committee on Radio Interference, sub-committee of the International Electrotechnical Commission IEC). EN 55022 is its European counterpart and is a harmonised standard under the EMC Directive. Both standards deal with "Information Technology Equipment (ITE) – Radio disturbance characteristics – Limits and methods of measurement". The limits given in both standards are equal.

The Information Technology Equipment has two terminals, the mains port and the telecommunication port, and the limits set for these ports are different. ITE is subdivided into two categories denoted Class A ITE and Class B ITE: Class B ITE is intended primarily for use in the domestic environment and has to satisfy the more stringent Class B ITE limits. Class A ITE is a category of all other ITE and has to satisfy the Class A ITE limits, which are less stringent.

In the HF range the Class B ITE limits are:

a)	for the mains port:	0.5 to 5 MHz	56 dBµV Quasi-peak
	(disturbance voltage)	5 to 30 MHz	60 dBµV Quasi-peak
b)	for the telecommunication port:	0.5 to 30 MHz	43 dBµA Quasi-peak
	(conducted common mode [asymmetric mode] current)		

These limits may not be applicable to the new broadband wire-line telecommunication networks because of the differences of the radio signals emitted by equipments and networks: on one hand the characteristics of the interfering signals are quite different (bandwidth, duration, level vs. frequency, see Section 2.4), and on the other hand ITE and networks differ largely in their dimensions, and thus, in their effective antenna gain.

For that reason, activities had been initiated globally to find new limits for the broadband wire-line telecommunication networks. Nevertheless, for the networks, there is the tendency to settle on the same limits as for equipment.

Other international standards dealing with radio disturbance by different types of equipment are:

- CISPR 11 / EN 55011: "Radio disturbance characteristics of Industrial, Scientific and Medical (ISM) equipment"; and
- CISPR 15 / EN 55015: "Lighting Equipment – Radio disturbance characteristics – Limits and methods of measurement".

The limits of these standards may be taken from Sections 4.2.1 and 4.2.2 in ECC Report 24 [3].

In Germany, field strength limits for emissions from wire-line telecommunications have to be fulfilled since 2001. These limits, known as Usage Provision 30 (Nutzungsbestimmung 30: NB 30), are part of the so called "Order on the Table of Frequency Allocations (German designation: FreqBZPV)", were first

published on 26 April 2001, and set into order on 1 July 2001 [12]. Later, this national order had to be retracted and was reintroduced (republished October 2004) [88]. The NB 30 field strength limits specified at a 3 metre distance to the wire-line are shown (together with other limits proposed) in Figure 4.1-1. They had been chosen as a compromise between the interests of both parties: wire-line and radio users.

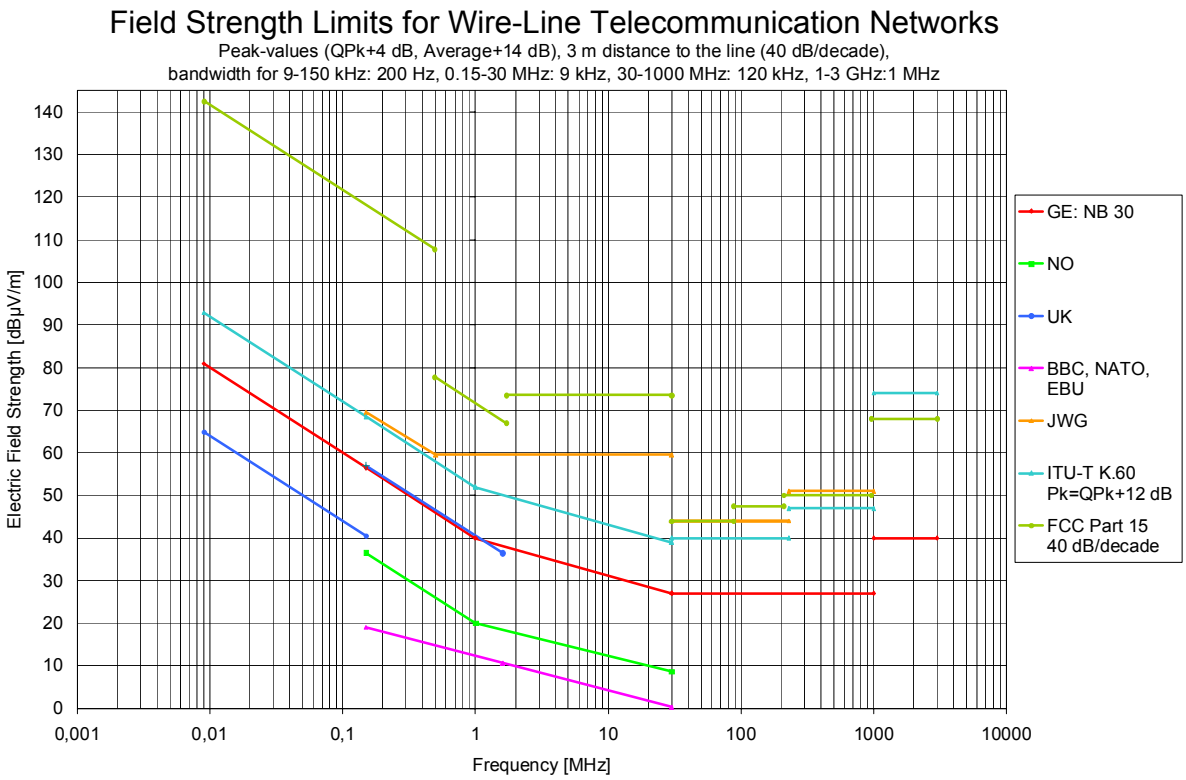

Figure 4.1-1: Field Strength Limits Proposed for Broadband Wire-Line Telecommunication Networks. All limits extrapolated to 3 metre measurement distance.

The general EMC requirements in the U.S.A. are set by the Federal Communications Commission (FCC). FCC Part 15 Rules cover equipment capable of (not deliberately) emitting RF energy in the range of 9 kHz – 200 GHz.

FCC Report and Order [31] published in October 2004, adopts new requirements and measurement guidelines for Access BPL (1.705 – 80 MHz). It states that the existing Part 15 radiated emission limits have to be applied to Access BPL systems. These limits, for comparison reasons, converted to Peak values and to a 3 metre measuring distance to the line, are shown in Figure 4.1-1 (Note: the conversion factor 40 dB/decade recommended by FCC for other measuring distances was not confirmed by measurements carried out by other organisations). In the HF range, the FCC limit of 73.5 dBµV/m is independent of frequency.

These new FCC regulations contain some requirements for adaptive interference mitigation techniques, as [31],[90], Section 15.611 (c):

- Remotely reduce power and adjust operating frequencies, in order to avoid site-specific, local use of the same spectrum by licensed services. These techniques may include adaptive or “notch” filtering, or complete avoidance of frequencies, or bands of frequencies, locally used by licensed radio operations. When a notch filter is used to avoid interference to a specific frequency band,

the Access BPL system shall be capable of attenuating emissions within that band to a level at least 20 dB (< 30 MHz) respectively 10 dB (> 30 MHz) below the applicable Part 15 limits.

- Comply with applicable radiated emission limits upon Access BPL system power-up following a fault condition, or during a start-up operation after a shut-off procedure, by the use of a non-volatile memory, or some other method, to immediately restore previous settings with programmed notches and excluded bands, to avoid time delay caused by the need for manual re-programming during which protected services may be vulnerable.
- Incorporate a remote-controllable shut-down feature to deactivate, from a central location, any unit found to cause harmful interference, if other interference mitigation techniques do not resolve the interference problem.

4.2 PROPOSED LIMITS

In Europe, deployment of power line communication systems is subject only to a general authorisation pursuant to Directive 2002/20/EC of the European Parliament and of the Council of 7 March 2002 on the authorisation of electronic communications networks and services.

In 2001, the European Commission (EC) called upon the European Standardisation Organisations to draft harmonised European standards for wire-line networks. It mandated a Joint Working Group (JWG) consisting of members from CEN (European Standardisation Committee), CENELEC (European Committee for Electrotechnical Standardisation) and ETSI (European Telecommunications Standards Institute) to prepare standards for the new broadband wire-line telecommunication networks, which "are currently operational or under development" [8]. According to this Mandate M/313, the JWG 2003 prepared a draft of harmonised standards for discussion, containing current and field strength limits as well as disturbance emission measurement methods [9]. The field strength limits in this draft were identical to that marked by "JWG" in Figure 4.1-1.

As agreement could not be reached regarding these standards, the EC in April 2004 drafted a "Technical Specification for electromagnetic emissions from access powerline communications networks" [10] and a "Guide for in situ measurements – In situ measurement of disturbance emission" [11], which was voted upon separately by CENELEC and ETSI, without reaching a consensus. In the HF range, the conducted common mode (asymmetric mode) current limit is 30 dBµA Quasi-peak and the corresponding magnetic field strength limit (using Biot-Savart's law) at a 3 metre distance to the power line for a 9 kHz measurement bandwidth (method of measurement described in [10], paragraph 5.3 and in [11], paragraph 7) is 4 dBµA/m Quasi-peak. This limit, converted to electrical field strength in free space according to equation (4-1) and to Peak-value for comparison purposes with other field strength limits, is shown in Figure 4.1-1 (orange line marked JWG) for the frequency range 150 kHz – 1000 MHz. In the HF range this field strength limit is constant 59.5 dBµV/m.

$$E\,[\mathrm{V/m}] = H\,[\mathrm{A/m}] \bullet Z_0\,[\Omega] \qquad (4\text{-}1)$$

with $Z_0 = (120 \bullet \pi)\ \Omega$ impedance of free space

The Technical Specifications [10] and [11] (regarding compliance verification) for Access power line communication networks aim at: (1) rapid and multiple deployment of broadband power line communication technology; and (2) to collect experience on radio interference. Therefore, these specifications allow relatively high field strength limits.

The majority of the CENELEC and ETSI members voted against the Technical Specifications [10] and [11], so these were rejected, and the JWG drafted a new "Product family emission standard for wire-line

telecommunication networks" [44],[92]. Closure dates for comments on this new draft were 2005-12-16 for CENELEC and 2005-11-18 for ETSI.

As of April 2005, the EC again recommended promotion of power line communications by its Member States, considering that power line communication systems fall within the scope of the EMC Directive:

- In case of radio interference, the national authorities should perform in situ measurements considering that only a common mode current limit now [44],[92] is prescribed in the HF range (30 dBµA Quasi-peak, [10]); the corresponding field strength limit (59.5 dBµV/m) is identical to the standards in CISPR 22 / EN 55022 for Class B ITE, once more recommended by the JWG for the wire-line telecommunication networks (orange line in Figure 4.1-1).
- Further the national authorities should recommend measures to reduce/avoid the interference.
- Finally they should report such cases to the EC every half year, beginning end of 2005.

As of February 2006, it was decided [50] that the draft emission standard [44],[92] should not be put to the vote at this time, but should be archived while the work on the draft emission standard was frozen. It should be resumed some time in the future when new technology was in place.

For the time being in Europe "there are therefore no limits for radiation from networks" [50].

On the European Commission Recommendation of 6 April 2005 the JWG also drafted a "Code of Practice" for PLT trials [62]. It deals with a number of issues relating to the deployment of PLT systems, but concentrates on measurement methodology and reporting, which should lead to an effective evaluation of the impact of PLT systems on radio communications services and other cable networks. The application of these principles is voluntary, but could assist the EC in any standardisation process and the collation of data received from Member States.

In case of complaints, national regulatory authorities are allowed to take special measures at a specific site in order to overcome the problem. In June 2005, CEPT adopted the ECC Recommendation (05)04 about the assessment of complaints caused by telecommunications networks. This Europe-wide recommendation reflects in principle the NB 30 requirements [64].

Austria and Germany together have proposed a "Notching Concept for PLC" recommending permanent, dynamic and programmable notching [63]. The Amateur Services frequency bands, as well as the Broadcasting bands, which are used 24 hour a day, all globally allocated according to ITU Radio Regulations, should be notched permanently. Broadcasting frequency bands used only part of the day or locally, also allocated worldwide according to ITU, should be notched dynamically. Security radio services, as well as Low Power Devices, should be protected by programmable notches. Notching depth should be at least 30 dB.

The effects of broadband wire-line telecommunication networks on radio services and applications were investigated in detail by CEPT ECC and are described in ECC Report 24 [3]. Figure 4.1-1 shows field strength limits for protection of radio reception proposed by different European countries and organisations and by ITU. Additionally it contains the U.S.-Standard FCC Part 15, valid for a 30 metre distance to the line and transformed here to a 3 metre distance on base of 40 dB/decade recommended by FCC because of near-field situation. The different limits in Figure 4.1-1 are:

- GE: NB 30 limits proposed by and valid in Germany since 2001 (Nutzungsbestimmung 30) and supported by several other European countries. According to [3], which was "adopted in CEPT by Competent National Authorities", the tightened limits "are considered as maximum tolerable levels as far as radio services protection is concerned". NB 30 limits are not valid for frequencies used by "safety and emergency related radio services" (no interference at all allowed).

- NO: Limits proposed by Norway and supported by some other CEPT administrations, approximately 20 dB below NB 30, "may be regarded as sufficient to protect radio services in the majority of cases" [3].
- BBC, NATO, EBU: limits proposed by BBC and NATO and "supported by the radio users (military, broadcasting/EBU, civil aviation, amateur…) of the LF, MF and HF bands" [3]: Degradation of Sensitivity no more than 0.5 dB (increase of total noise by interference 10 metre distant to the line, reference noise level to be considered is the mid-way noise level of quiet-rural and rural areas defined in the ITU-R P.372-8 [86]). DERA experiments [4] showed that even an accumulated 3 dB worsening of the background noise caused by deployed VDSL or PLT sources severely affected data rates and/or circuit availability. The Absolute Protection Requirement proposed in Section 2.4 is partly based on this finding. Subsequently, DERA advised that to prevent this overall effect, the noise floor at a 3 metre distance to the VDSL- or PLT-lines should be limited to that of the BBC, NATO-curve.
- JWG: These limits proposed by the EC for use in Europe are identical with CISPR 22 / EN 55022 limits valid for Class B ITE.
- ITU-T SG 5 limits approved and recommended internationally, 12 dB higher than NB 30. ITU additionally recommended Quasi-Peak limits equal to NB 30-values (Peak-limits), i.e., ITU-levels shown here perhaps should be 8 dB lower, as most organisations measured only 4 dB (instead of 12 dB) difference between QPeak- and Peak-values.
- FCC Part 15 limits valid in the U.S.A. for application to Broadband over Power Line (BPL: the North American term for PLT) systems [31],[90],[14].

In case of complaint, the methods of measuring conducted disturbance emissions from broadband wire-line telecommunications in the HF range regarding JWG-limits are described in [44],[92] and corresponding methods of field strength measurements for comparison with NB 30 limits are described in [12],[88]. Another guidance on field strength measurement method was developed and agreed to in the framework of CEPT/ECC/SE35 and issued by ITU [15]. In either case, these documents recommend that measurements should be carried out at a 3 metre distance to the line using a 9 kHz measurement bandwidth. Because of that high bandwidth, care should be taken that the measurements will not be influenced by HF radio signals.

4.3 INTERNATIONAL REGULATORY STATUS

The new broadband wire-line telecommunication technique is promoted globally, in order for everyone to have the means of exchanging lots of data via the Internet. The cheapest way is to use the existing wire-line infrastructure, i.e., power and/or telephone lines. Power lines are most widespread, but have the worst technical characteristics for emitting broadband noise-like signals, when transmitting high data rate signals (several Mbps). On one hand there is not much experience regarding radio interference by this new telecommunications technique, and on the other hand, there are big commercial interests promoting its realisation and multiple use.

The field strength- and common mode current-limits set in United States and proposed in Europe are relatively high (curves FCC Part 15 and JWG in Figure 4.1-1). However, FCC as well as the EC believe that these limits are appropriate to control the radio interference problem.

FCC and the EC recommend promotion of the BPL/PLT technique, its realisation and gathering experience with regard to radio interference. In case of radio interference, they both recommend measures to reduce/avoid the interference. After a period of having gathered experience, the existing limits again will be discussed.

Different nations in Africa (South Africa, etc.), Asia (Japan, South Korea, China, India, etc.) and Australia are in the experimental phase performing BPL/PLT field trials. Proposals by these nations for field strength or common mode current limits are not known to the Task Group. Australia seems to be on the way to set limits for protection of radio systems [46], but this work is in its early stages and no numbers are available yet.