ETSI TR 102 259 V1.1.1 (2003-09)

Technical Report

PowerLine Telecommunications (PLT); EMI review and statistical analysis

Reference

DTR/PLT-00013

Keywords

methodology, powerline, transmission

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://webapp.etsi.org/IPR/home.asp).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Powerline Telecommunications (PLT).

Introduction

In order to study and compare characteristics of the LVDN network in different countries a STF (Special Task Force) was set-up. The present document is one of the four TRs which present the result of the work (TR 102 258 [2], TR 102 269 [3] and TR 102 270 [4]).

The present document takes into account matters like earthing variations, country variations, operator differences, phasing and distribution topologies, domestic, industrial housing types along with local network loading.The measurement set-up, the measurements as such, the used software the site reports and parts of the analysis are common for all the TRs and is collected in the TR 102 270 [4].

1 Scope

The present document presents the results from EMI measurements performed in Germany, the Netherlands and Spain. It investigates the distribution of the EMI values in respect to the frequency and to the national LVDN-particularities (wiring technology, earthing, etc.).

2 References

For the purposes of this Technical Report (TR) the following references apply:

[1] ETSI TR 102 175: "Powerline Telecommunications (PLT); Channel characterization and measurement methods".

[2] ETSI TR 102 258: "PowerLine Telecommunications (PLT); LCL review and statistical analysis".

[3] ETSI TR 102 269: "PowerLine Telecommunications (PLT); PLT Hidden Node Analysis".

[4] ETSI TR 102 270: "PowerLine Telecommunication (PLT); Basic LVDN measurement data".

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

BALUN	BALanced to UNbalanced transformer
EDP	Electronic Data Processing
EMI	ElectroMagnetic Interference
LCL	Longitudinal Conversion Loss
LVDN	Low Voltage Distribution Network
STF	Special Task Force
ToR	Terms of Reference for Specialist Task Force 222 (MB), TC PLT, September 2002

4 Measurement method and measurement locations

A symmetric signal with a defined power is fed into the LVDN at an arbitrary plug. As source a comb generator is used in conjunction with a suitable balun. The magnetic field strength is measured in a horizontal distance of 3 m from the external wall of the building (as far as technically feasible). The total field strength is determined by geometrical addition of the three measured field components (x, y and z). Adding 20 x log(377) = 51,5 dB yield to an equivalent electrical field strength, which commonly is given as result of radiation measurements below 30 MHz.

The coupling factor in the present document is defined as the equivalent electrical field strength (in dB(μV/m)) related to the fed forward power (in dBm), both measured in a 9 kHz bandwidth. With this definition a coupling factor of 50 (dB(μV/m)-dBm) means an equivalent electrical field strength of 50 dB(μV/m) when a forward power of 0 dBm (1mW) is fed into the LVDN.

For many measurement sites several measurement locations have been chosen. For each of these measurement locations the signal feeding point is also varied.

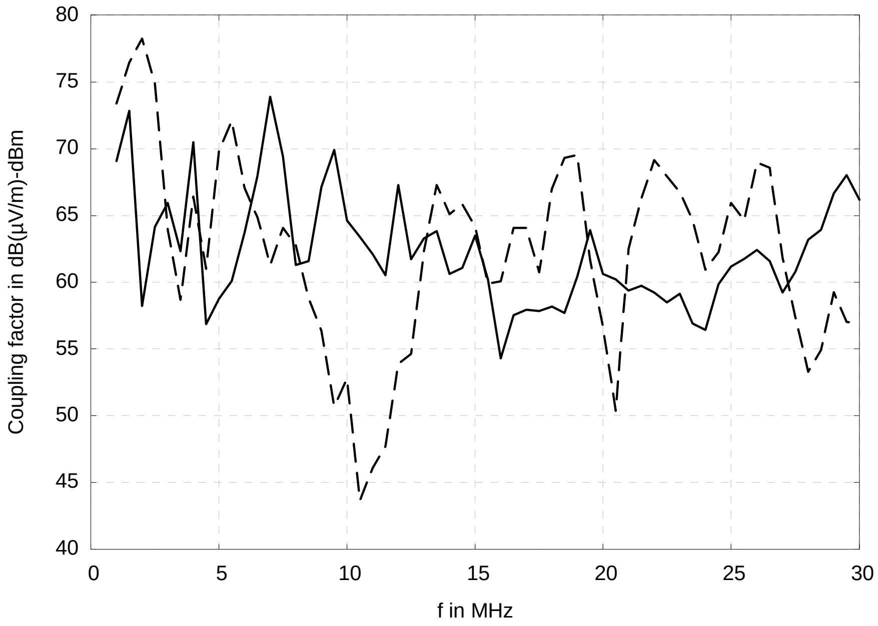
Several measurement locations have been chosen, so that different countries, different types of installations and different building usage are covered by the measurements. All measurements were performed during daytime with household appliances, EDP-equipment and production machinery normally connected to the mains. Further details of the investigated measurement locations can also be found in document [1].

In total the coupling factor of 98 plugs and antenna locations was measured. Each measurement consists of 59 measurement frequencies.

5 Example test results

The value of the coupling factor varies in general with frequency and measurement location. Therefore a statistical evaluation must be performed.

Figure 1 shows typical results of coupling factor measurements at two antenna locations on different measurement locations. Comparison of the different coupling factor plots show that no specific coupling factor behaviour can be observed regarding to the country or the installation types (single phase, three phase, earthing variations). Therefore it is not necessary to distinguish principle installation types.



NOTE: ———— : Germany
------------: Spain

Figure 1: Typical coupling factor measurement results of two antenna locations at different measurement locations

6 Frequency dependency

Figure 2 shows that the coupling factor behaviour can be regarded as constant over frequency.

Therefore all measurement points regardless of their frequency can be used for statistical evaluation.

Frequency dependency can be established by calculating the regression line (especially its slope) with the least squares method for each coupling factor measurement. From all slopes the cumulative probability can be obtained depending on the slope. This function is plotted in figure 2. It can be seen that there is a slight frequency dependency of about -0,16 (dB(µV/m)-dBm)/MHz. The decrease of coupling factor with increasing frequency can be explained by the attenuation of the lines, which also increases with frequency.

For the whole frequency range the medium slope yield to a total decrease of 4,8 dB (1 MHz to 30 MHz), which is within the measurement uncertainty. Therefore, the coupling factor will be evaluated independent of frequency.

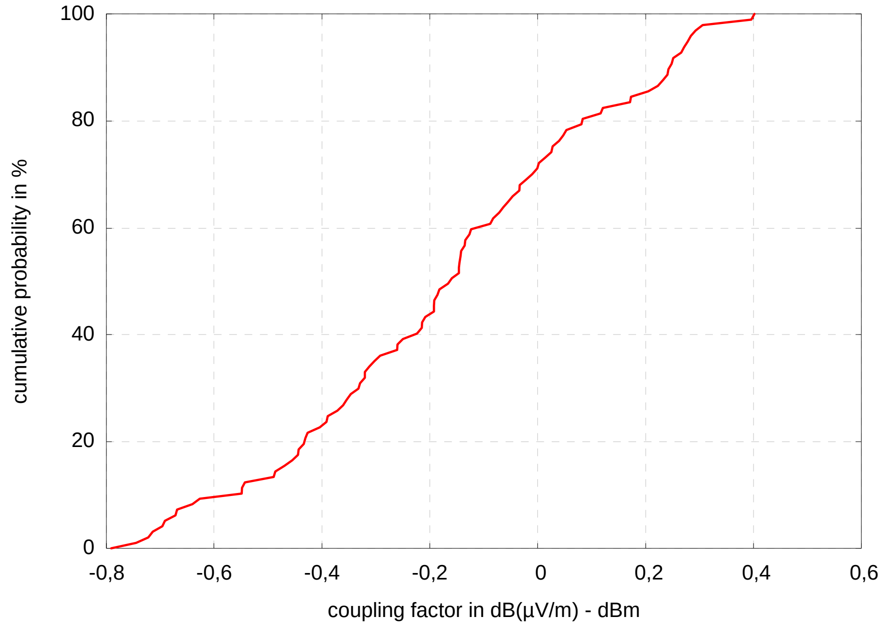


Figure 2: Cumulative probability of the slope of the regression line for the coupling factor

7 Statistical evaluation of measured coupling factor

Taking into account all frequencies and locations, the cumulative probability in dependence of the mean coupling factor for each site is plotted in figure 3. As it can seen from this curve, the median (50 %-cum.prob.) is 61,2 dB(µV/m)-dBm and the 80 % is less than 63,2 dB(µV/m)-dBm.

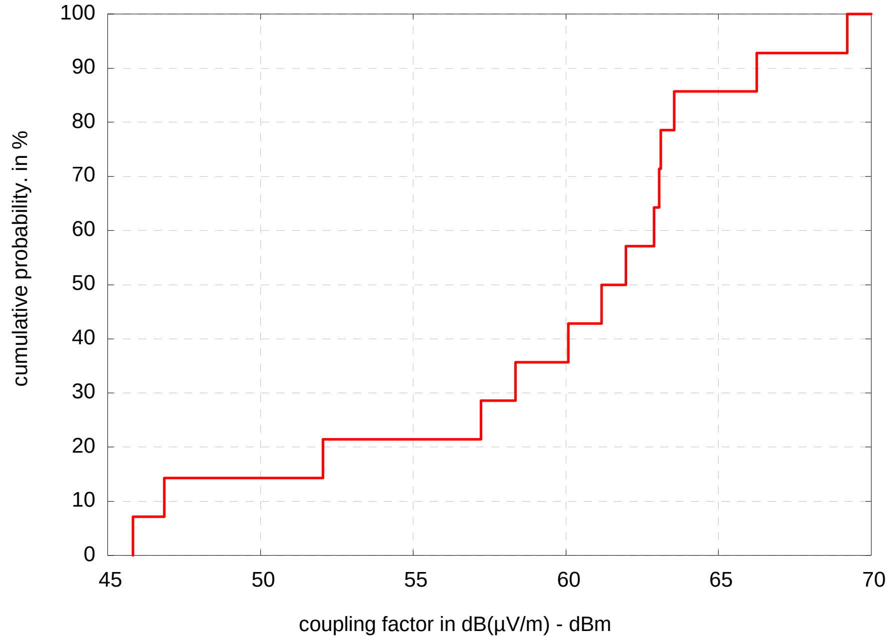


Figure 3: Cumulative probability in dependence of mean coupling factor for all measurement frequencies and locations

8 Dependencies from national particularities in Installation - and earthing techniques in Germany, the Netherlands and Spain

Table 1 shows the evaluated coupling factor-values measured in the three countries.

Table 1

Country	Area	Coupling factor
Germany	Stuttgart	62,3 dB(µV/m)-dBm
The Netherlands	Eindhoven	67,6 dB(µV/m)-dBm
Spain	Zaragoza	58,7 dB(µV/m)-dBm

In addition to national dependences the data is analysed according to installation types, i.e. installations with three phases or single phase per flat/house (see table 2).

Table 2

Installation type	Coupling factor
Three phases	58,9 dB(µV/m)-dBm
Single phase	63,9 dB(µV/m)-dBm

Considering the measurement uncertainty of in situ field strength measurements, no significant differences of the coupling factor can be justified regarding national particularities of installations.

9 Correlation between LCL and coupling factor

For determination of any correlation between LCL and coupling factor the pre-evaluated coupling factor values (mean values of a single measurement site) are plotted dependent on the pre-evaluated LCL values as shown in figure 4. Obviously the LCL values of the different measurement sites (with exception of the extremely low LCL value of an industrial site in Spain) differ not much from each other. Furthermore, the variation of coupling factor is in the range of the measurement uncertainty of in-situ field strength measurements. Therefore, a correlation between LCL and coupling factor can neither be established nor excluded.

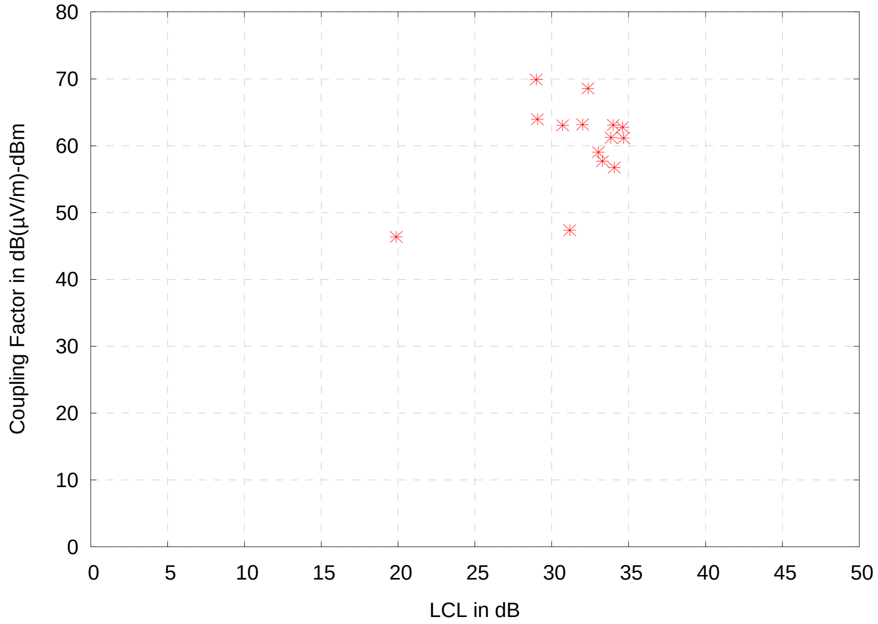


Figure 4: Mean value of coupling factor as a function of mean value of LCL for the different measurement sites

History

Document history		
V1.1.1	September 2003	Publication