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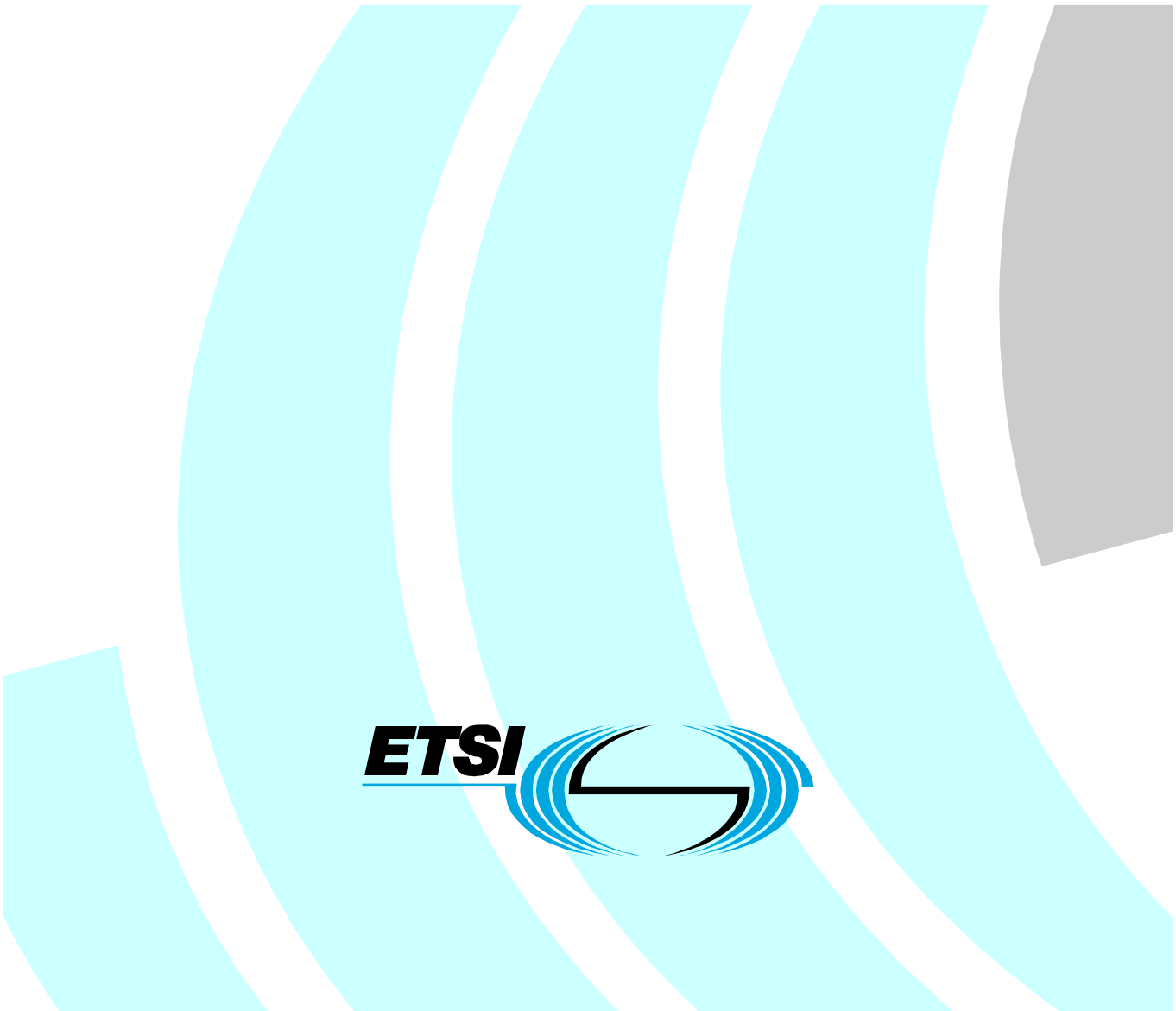
Technical Report

PowerLine Telecommunications (PLT); LCL review and statistical analysis



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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 102 259 [4], TR 102 269 [5] and TR 102 270 [6]).

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 [6].

1 Scope

The present document presents the results from LCL measurements performed in Germany, The Netherlands and Spain. It investigates the distribution of the LCL 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] ITU-T Recommendation G.117 (1996): "Transmission aspects of unbalance about earth".

[2] Ian P. Macfarlane: "A probe for the measurement of electrical unbalance of networks and devices", IEEE Transactions on Electromagnetic Compatibility, Vol. 41, Issue 1.

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

[4] ETSI TR 102 259: "PowerLine Telecommunications (PLT); EMI review and statistical analysis".

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

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

3 Abbreviations

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

EDP	Electronic Data Processing
LCL	Longitudinal Conversion Loss
LVDN	Low Voltage Distribution Network
STF	Special Task Force
ToR	Terms of Reference

4 Measurement method and measurement locations

The measurements have been performed with a LCL-measurement adapter according to Macfarlane [2]. The differential mode design impedance is Z = 100 Ω. The measurements corresponds to the LCL-definition of ITU-T Recommendation G.117 [1]. The protection earth at the socket to be measured was not connected to the ground plane. The size of the ground plane representing reference potential for the asymmetric mode is chosen in a way that changes of its size or low inductive connections to grounded structures (water pipes) does not influence the measurements (especially at low frequencies). The effect of measurement errors due to insufficient capacitive coupling to ground, as discussed in CISPR/I was not observed with this layout.

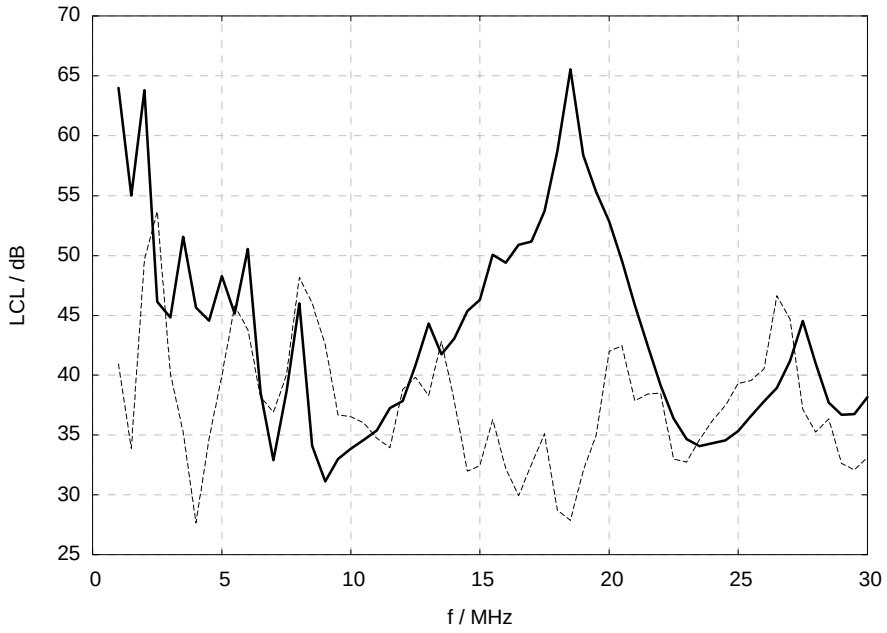
Several measurement locations have been chosen, so that different countries, different types of installations and different building usage are covered by the measurements. All measurements were performed during day-time with household appliances, EDP-equipment and production machinery normally connected to the mains.

In total the LCL of 68 plugs was measured. Each measurement consists of 59 measurement frequencies.

5 Example test results

The value of LCL varies in general with frequency and measurement location. Therefore a statistical evaluation must be performed in order to consider not the absolute worst case but a case, for which it can be guaranteed that most of the plugs of the LVDN are better than this case.

Figure 1 shows typical results of LCL measurements at two plugs on different measurement locations. Comparison of the different LCL plots shows that no specific LCL behaviour can be observed regarding to the country or the installation types (single phase, three phase, and earthing variations). Therefore it is not necessary to distinguish between principle installation types. A slight variation was found regarding usage of the building. Industrial usage with many installed tool machines yields to lower LCL values. However the slight difference and the small number of industrial sites do not justify a separate statistical evaluation.



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

Figure 1: Typical LCL measurement results of two plugs on different measurement locations

6 Proof of frequency independence

If the LCL behaviour shows no general tendency with frequency, all measurement points regardless of frequency can be used for statistical evaluation. A general frequency dependence can be established by calculating the regression line (especially its slope) with the least squares method for each LCL measurement location. From all slopes the cumulative probability can be obtained in dependence of the slope. This function is plotted in figure 2. It shows that the variance of the slope is low. The median value of the slope is nearly 0 dB/MHz. With this result the frequency independence of LCL is proven.

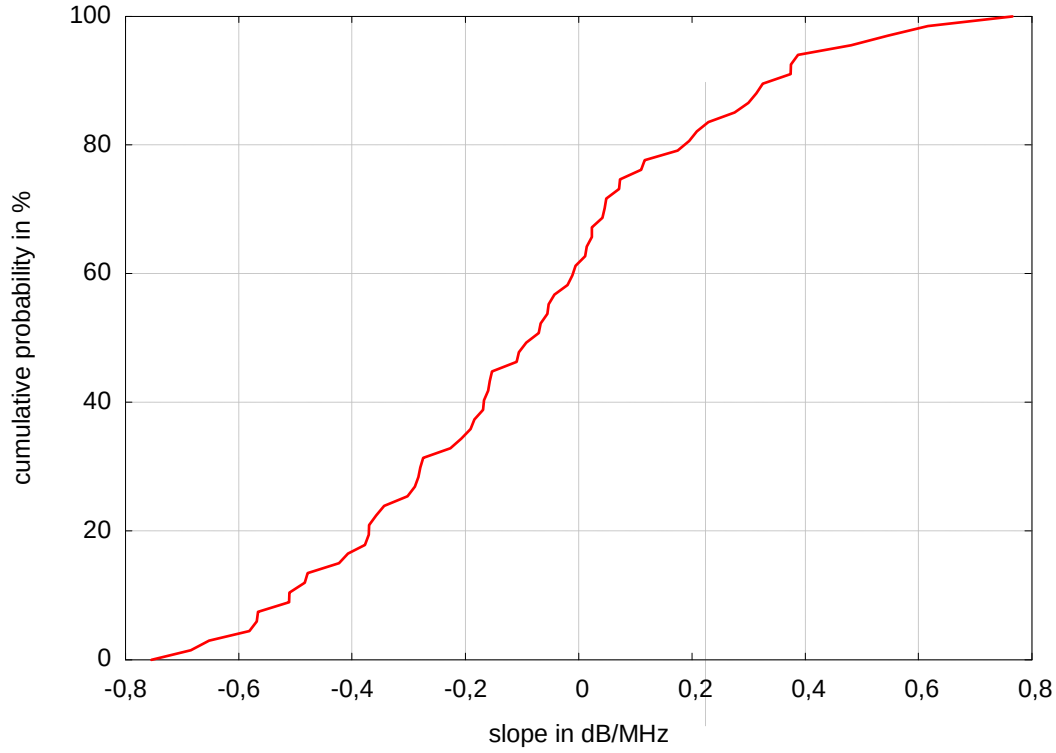


Figure 2: Cumulative probability of the slope of the regression line for the LCL –frequency plots

7 Statistical evaluation of the measured LCL

Taking into account all frequencies and locations (without pure industrial sites) the cumulative probability in dependence of the mean LCL for each site is plotted in figure 3. As it can be seen from this curve, the median LCL (50 %-value) is 33,0 dB and 80 % of all measurement sites show a LCL of more than 30,7 dB.

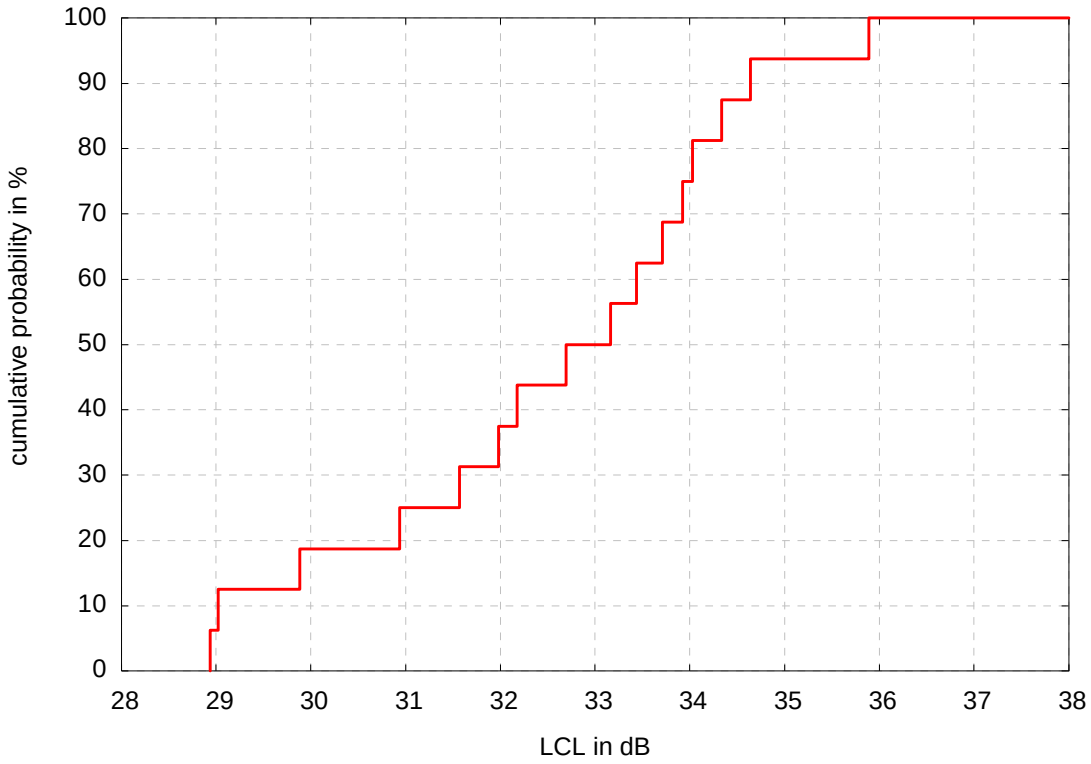


Figure 3: Cumulative probability in dependence of mean LCL for all measurement frequencies and locations

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

For comparison table 1 shows the evaluated LCL-values measured in the three countries (excluding factories, which were only measured in Spain and for which the statistical basis is insufficient).

Table 1

Country	Area	LCL (dB)
Germany	Stuttgart	31,6
The Netherlands	Eindhoven	29,9
Spain	Zaragoza	32,3

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

Table 2

Installation type	LCL (dB)
Three phases	31,0
Single phase	32,2

No significant difference can be detected.

History

Document history		
V1.1.1	September 2003	Publication