



**PowerLine Telecommunications (PLT);
MIMO PLT;
Part 3: Setup and Statistical Results of MIMO PLT Channel and
Noise Measurements**

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Foreword

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

The present document is part 3 of a multi-part deliverable covering the MIMO PLT as identified below:

- Part 1: "Measurement Methods of MIMO PLT";
- Part 2: "Setup and Statistical Results of MIMO PLT EMI Measurements";
- Part 3: "Setup and Statistical Results of MIMO PLT Channel and Noise Measurements".**

Introduction

The STF 410 (Special Task Force) was set up in order to study and compare MIMO (Multiple Input Multiple Output) characteristics of the LVDN network in different countries. The present document is one of three parts of TR 101 562 which contain the findings of STF 410 research.

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1 Scope

MIMO PLT Channel and noise is reviewed and statistical analysis performed, which takes into account earthing variations, country variation, operator differences, phasing and distribution topologies, domestic, industrial and residential types, as well as local network loading.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

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NOTE: While any hyperlinks included in this document were valid at the time of publication, ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] Sartenaer, T. & Delogne, P., "Powerline Cables Modelling for Broadband Communications", ISPLC 2001, pp. 331-337.
- [i.2] R. Hashmat, P. Pagani, A; Zeddami, T. Chonavel, "MIMO Communications for Inhome PLC Networks: Measurements and Results up to 100 MHz", IEEE International Symposium on Power Line Communications and its Applications (ISPLC), Rio, Brasil, March 2010.
- [i.3] A. Schwager, "Powerline Communications: Significant Technologies to become Ready for Integration" Doctoral Thesis at University of Duisburg-Essen, May 2010.
- [i.4] CISPR 16-1-1: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus".
- [i.5] ETSI TR 101 562-1 (V1.3.1): "Powerline Telecommunications (PLT); MIMO PLT; Part 1: Measurement Methods of MIMO PLT".
- [i.6] ETSI TR 101 562-2 (V1.2.1): "PowerLine Telecommunications (PLT); MIMO PLT; Part 2: Setup and Statistical Results of MIMO PLT EMI Measurements".
- [i.7] Paulraj, A., Nabar, R. & Gore, D.: "Introduction to Space-Time Wireless Communications"; Cambridge University Press, 2003.

3 Symbols and abbreviations

3.1 Symbols

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

B	Bandwidth
C	Channel Capacity
D	Diagonal Matrix
f	Frequency
k	kilo, most used at kilo Ohms
H	Channel Matrix
Hz	Hertz
I	Current
L	Inductance
λ	Singular Value or Eigen Value
nF	nanoFarads
R	Resistor
U,V	unitary matrices
uH	micro Henry
Z	Impedance

3.2 Abbreviations

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

AC	Alternating Current
ADC	Analog to Digital Converter
AGC	Automatic Gain Control
AMN	Artificial Mains Network
AMP	Amplifier
AWG	Arbitrary Waveform Generator
BG	Band Gap
BNC	Bayonet Nut Connector
C-CDF	Complementary Cumulative Distribution Function (1-CDF)
CDF	Cumulative Distribution Function
CM	Common Mode
CSV	Comma Separated Values
DAC	Digital to Analog Converter
DC	Direct Current
DM	Differential Mode
DSO	Digital Storage Oscilloscope
E	Protective Earth Contact
EMC	Electromagnetic Compatibility
EMI	Electro Magnetic Interference
FD	Frequency Domain
FM	Frequency Modulation
HD-TV	High Definition Television
HP	High Pass
IF	Intermediate frequency
LCZC	Line Cycle Zero Crossing
LISN	Line Impedance Stabilization Network
LP	Low Pass
LVDN	Low Voltage Distribution Network
MIMO	Multiple Input Multiple Output
MS	Mega Sample
N	Neutral contact
N _R	Number of Receive ports