



PowerLine Telecommunications (PLT); BPSK Narrow Band Power Line Channel for Smart Metering Applications

[CEN EN 14908-3:2006, modified]

Reference

DTS/PLT-00032

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Contents

Intellectual Property Rights	4
Foreword.....	4
Introduction	4
1 Scope	5
2 References	5
2.1 Normative references	5
2.2 Informative references.....	5
3 Abbreviations	5
Endorsement notice	6
Global modifications to EN 14908-3:2006.....	6
History	12

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Powerline Telecommunications (PLT).

Introduction

The present document specifies a high-performance narrow band power line channel for control networking in the smart grid that operates in the EN 50065-1 [2] 9 kHz to 95 kHz sub-band ("A band") and is compatible with the CEN EN 14908 Open Data Communication in Building Automation, Controls and Building Management Control Networking standard and other protocols. The present document is suitable for smart grid applications such as, but not limited to, smart metering, distribution line management, distributed generation, electric vehicle charging and demand response.

This channel definition does not include built-in support for co-existence of dissimilar transceiver types at the PHY/MAC layer. Sharing of the media with other dissimilar technologies, for example, by segmenting access time to the channel or adjusting the duty cycle, is the responsibility of upper levels of protocols that make use of the present document.

1 Scope

The present document contains all the information necessary to facilitate the exchange of data and control information over the power line medium between devices that share the same LV transformer(s) within a utility's electricity network.

Certain aspects of the present document are defined in other documents. These documents are referenced where relevant. In the case where a referenced standard conflicts with the present document, the present document will prevail.

The present document provides the necessary adaptations to the endorsed document [1].

The present scope replaces in its entirety the scope of the endorsed document [1].

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 referenced document (including any amendments) applies.

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2.1 Normative references

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

- [1] CEN EN 14908-3:2006: "Open Data Communication in Building Automation, Controls and Building Management - Control Network Protocol - Part 3: Power Line Channel Specification".
- [2] CENELEC EN 50065-1:2011: "Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz - Part 1: General requirements, frequency bands and electromagnetic disturbances".

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] CEN EN 14908-1: "Open Data Communication in Building Automation, Controls and Building Management - Control Network Protocol - Part 1: Protocol Stack".

3 Abbreviations

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

AM	Amplitude Modulation
BPSK	Binary Phase Shift Keying
CNP	Control Network Protocol
LV	Low Voltage
NRZ	Non Return to Zero
PER	Packet Error Rate

PL	Power Line
PPM	Parts Per Million
RLC	Resistor, Inductor, Capacitor

Endorsement notice

The elements of CEN EN 14908-3:2006 [1] apply, with the following modifications:

NOTE: Underlining and/or strike-out are used to highlight detailed modifications where necessary.

Global modifications to EN 14908-3:2006

Clause 5.2 "Data Channel"

Shall be modified as follows:

The channel occupies the ~~125 kHz to 140 kHz~~ 9 kHz to 95 kHz frequency band, as defined in EN 50065-1, as a Binary Phase Shift Keyed (BPSK) modulated carrier. This channel is used to send protocol messages containing control, status, configuration and diagnostic information. The signalling characteristics of the channel are described in Clause 6 of EN 14908-3:2006.

Clause 5.6 "Surge Protection and Related Devices"

Shall be modified as follows:

Certain surge protection and related frequency selective protection devices may be installed on the power network. These devices may attenuate the CNP channel waveform sufficiently to prevent operation in part or the entire network. Precautions should be taken such that the device chosen does not substantially attenuate the signals in the ~~125 kHz to 140 kHz~~ 9 kHz to 95 kHz range.

Clause 6.4 "PL Packet Timing"

Shall be modified as follows:

As described in EN 14908-1, the protocol uses an interpacket spacing defined as a Beta1 time and randomising slots defined as Beta2 times. Beta1 is measured from the end of a packet to the beginning of the first Beta2 slot. The CNP protocol and PL transceiver in combination shall produce a Beta1 time of ~~3,4ms~~ 5,19 ms +/-0,1 ms and B2 times of ~~2,0ms~~ 3,05 ms +/-0,1 ms each. For optimum communication between nodes, there should be ~~8~~ 0 priority Beta2 slots. In addition, the transceiver shall meet the timing parameters defined below and specified in Table 1.

Carrier Detect - The time from when the beginning of the packet is at the receiver's input until the receiver has detected carrier and caused P_Channel_Active to be set to true.

Transmit Start Delay - The time from when P_Data_request is activated to when the beginning of the packet is initiated onto the power line.

Table 1 - Transceiver Timing Specifications

Parameter	Specification
Carrier Detect	1,7 ms max <u>2,93 ms max.</u>
Transmit Start Delay	100 µs max <u>153 µs max.</u>

Clause 6.5.1 "Carrier Modulation"

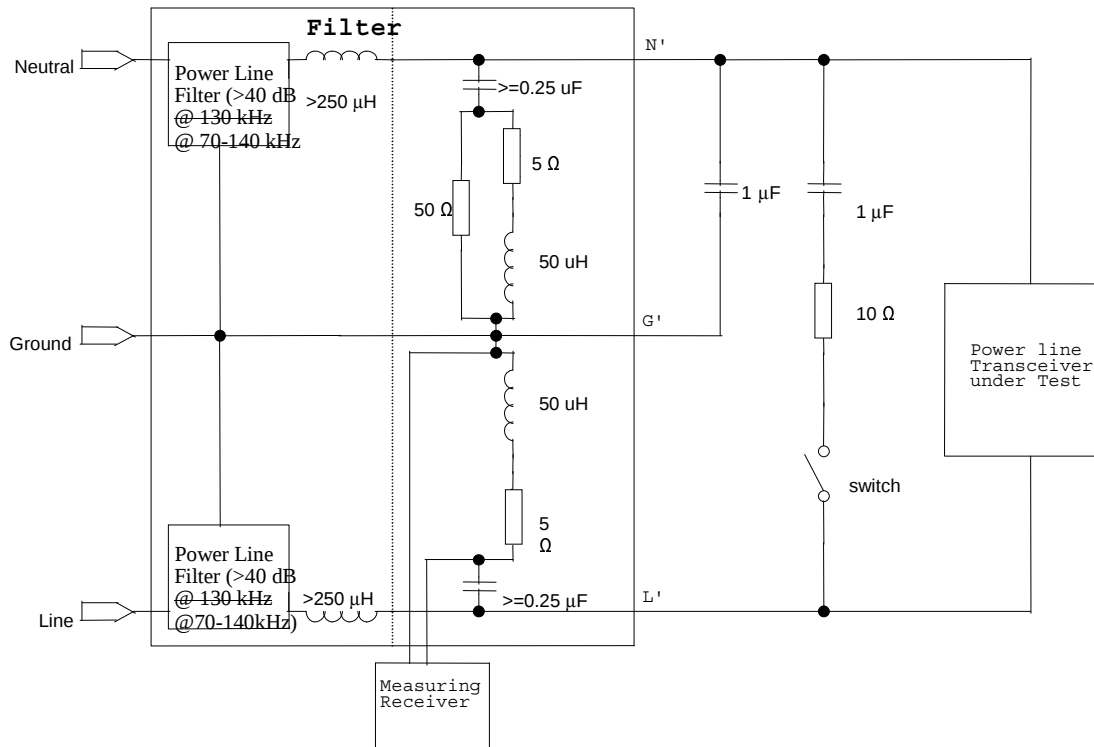
Shall be modified as follows:

The transmitter shall be a differential driver capable of driving the specified signal on the PL network. Each bit is sent as NRZ data BPSK modulated on to a carrier. The carrier frequency shall be ~~131,579 kHz~~ 86,232 kHz with a tolerance of ± 200 PPM. The symbol rate is ~~5482,45 symbols/sec~~ 3592,98 symbols/sec with a tolerance of ± 200 PPM. Note that appropriate shaping shall be performed on the modulated waveform to meet the requirements in EN 50065-1 for conducted emissions.

Clause 6.5.2 "Waveform Amplitude"

Shall be modified as follows:

The amplitude of the carrier output voltage during packet transmission should be measured at $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ using the test circuit shown in Figure 4. The V-network is an artificial network of $(50\text{ }\Omega // (50\text{ }\mu\text{H} + 5\text{ }\Omega))$ conforming to 8.2.1 of CISPR 16. The amplitude is measured using the tuned receiver at a frequency of ~~131,5 kHz~~ 86,2 kHz with a peak detector and a 30 kHz resolution bandwidth. The tuned receiver using its peak detector should read the rms value of a sinusoid. The amplitude limits shall be met both with switch closed and with the switch open. The transmit voltage will be calculated using the following formula $V_{pp} = 2,828 \times V_{measured}$ and $\text{dBV} = 20 \times \log_{10}(V_{measured})$. The transmit voltage $V_{measured}$ shall be greater than 0 dBV (2,828 Vpp) and less than 11 dBV (10,0 Vpp) when the switch is open and greater than -12 dBV (0,7 Vpp) when the switch is closed.

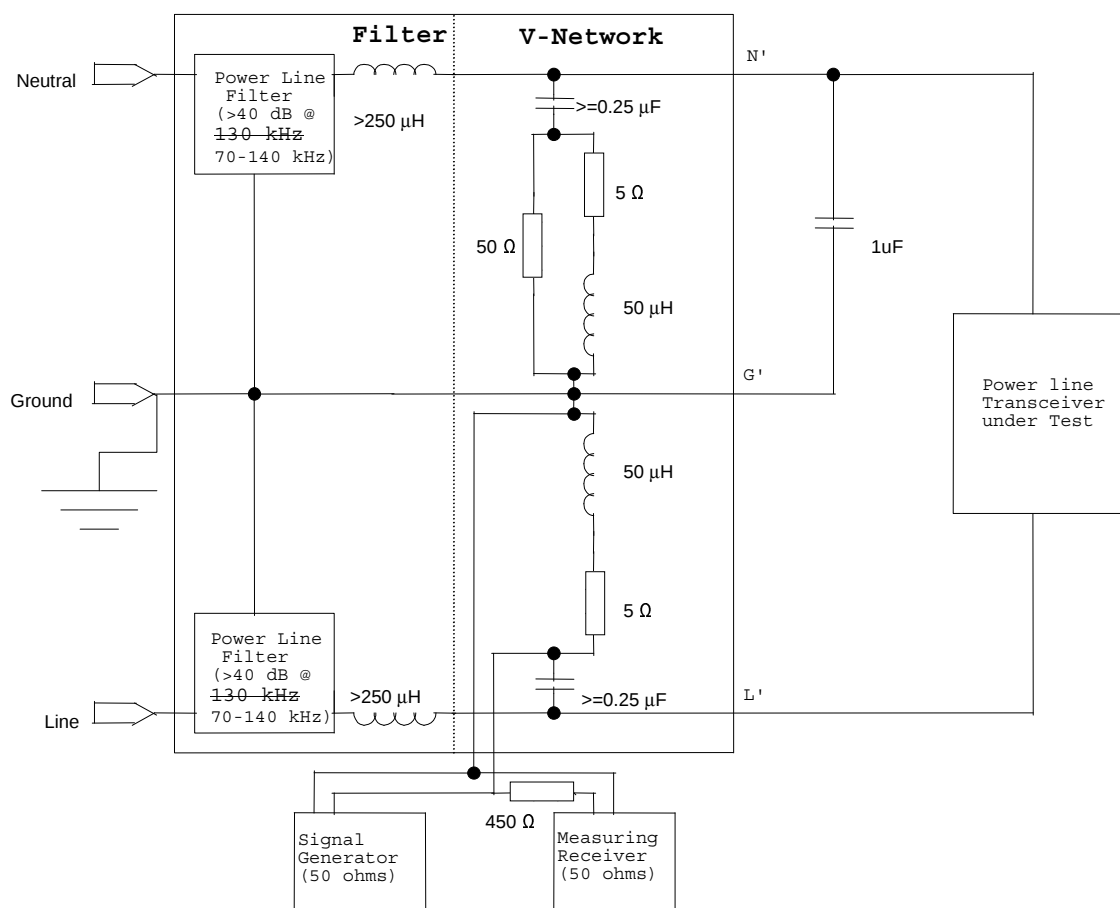


Key:

A Neutral	E V Network
B Ground	I Power line filter
C Line	J Power line transceiver under test
D Filter	S Switch

Figure 4 - Test Circuit for Determining Transmit Amplitude

Shall be modified as follows:

$$Z_e \equiv 50 * V_{ic} * \frac{Z_n}{V_{oc}(50 + Z_n) - V_{ic}(50 + Z_n)}$$


A Neutral	E V-Network
B Ground	I Power line filter
C Line	J Power line transceiver under test
D Filter	Y Signal Generator(50 Ω)

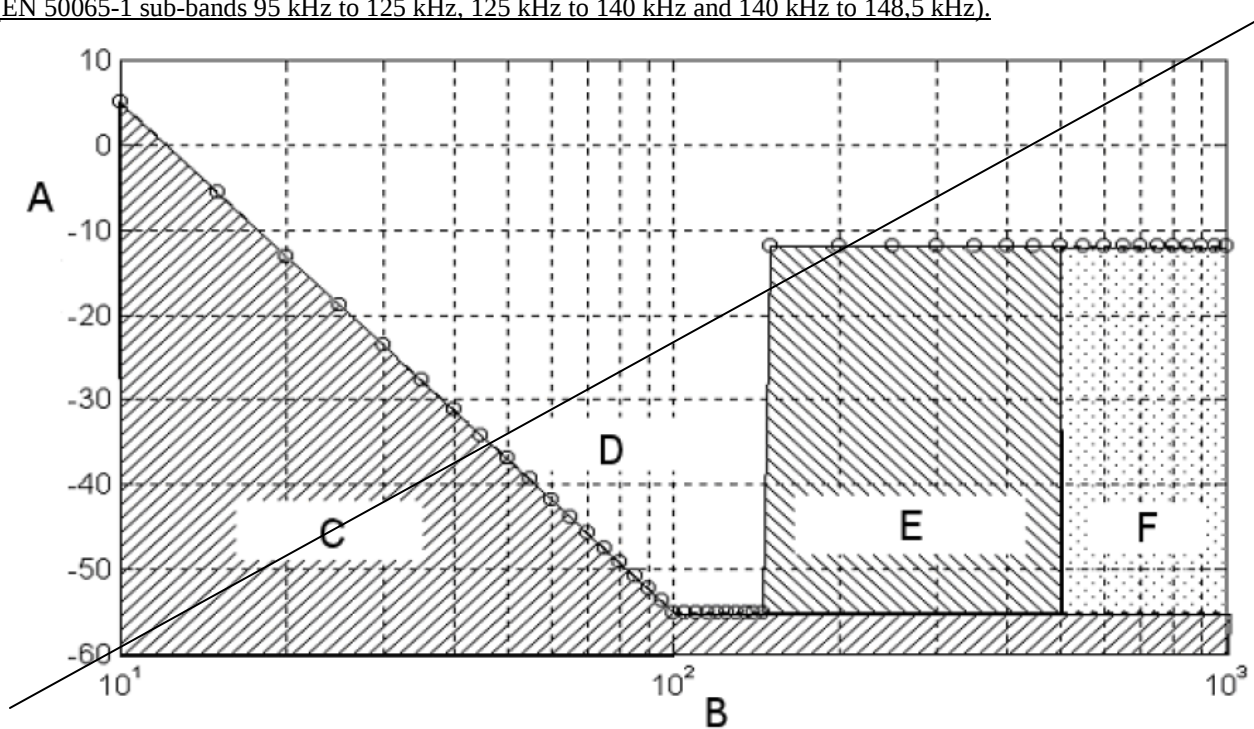
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Clause 6.6.4 "Receiving With Interference"

Shall be modified as follows:

This test is designed to measure the PL transceiver's immunity to interference at various frequencies. There are ~~four~~ three frequency bands of interference identified. Figure 7 depicts the ~~four~~ three bands and the performance specification. Power line noise is present throughout the entire frequency spectrum and generally increases in amplitude with decreasing frequencies.

Commercial broadcast signals can be at very high levels and for the purposes of the present document are defined to be between 150 kHz and ~~500 kHz~~ 1 MHz. European and North American AM broadcast is present at high levels because power lines act as antennas for radio broadcasts. The broadcast noise region for this test is defined to be between ~~500 kHz~~ 150 kHz and 1 MHz. The power line modem noise band is defined to be between ~~100 kHz~~ 95 kHz and 150 kHz (EN 50065-1 sub-bands 95 kHz to 125 kHz, 125 kHz to 140 kHz and 140 kHz to 148,5 kHz).



Key:

A Tone Level (dBv)	D Power Line Modem Region
B Frequency kHz	E Power Line Intercom and Broadcast Region
C Power Line Noise Region	F Broadcast Region

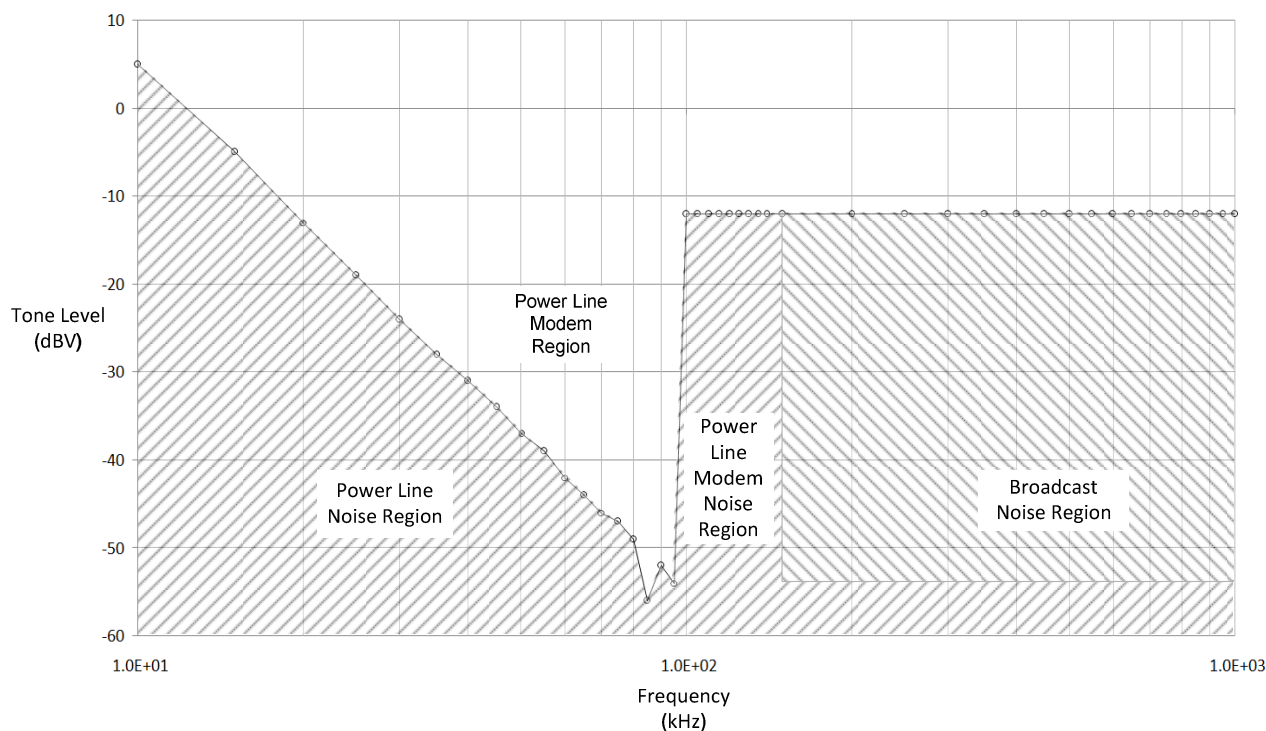


Figure 7 - Graph of Tone Interference Specification

The method of measurement is as follows. Referring to Figure 6^[1], switches SW1 and SW2 are open. The receive level is set to -47 dBV on the 50 Ω resistor of the V-network by adjusting R1 when the transmitter is sending packets. The signal generator is set to frequency and amplitudes as shown in Table 2. The frequency spacing is every 5 kHz from 10 kHz to 150 kHz and every 50 kHz from 150 kHz to 1 MHz. The interfering tone level (I_{tone}) is then measured with the tuned receiver. Then for each frequency and amplitude of tone the received packet error rate (PER%) shall be less than 2 %.

Table 2 - Settings for Receive Performance with Interfering Tone Test

Signal Generator Frequency	Interfering Tone Level (dBV)
10 kHz	5
15 kHz	-5
20 kHz	-13
25 kHz	-19
30 kHz	-24
35 kHz	-28
40 kHz	-31
45 kHz	-34
50 kHz	-37
55 kHz	-39
60 kHz	-42
65 kHz	-44
70 kHz	-46
75 kHz	-47
80 kHz	-49
85 kHz	-51 - 56
90 kHz	-52
95 kHz	-54
100 kHz-145 kHz	-56 - 12
150 kHz-500 kHz	-12
550 kHz-1 MHz	-12

Clause 6.6.5 "Receiving Through a Distorted Channel"

Shall be modified as follows:

This test is designed to measure the PL transceiver's immunity to frequency notches in the power line. The test circuit of Figure 6 is used with SW1 closed and SW2 open. The notch circuit is a series RLC network with values ~~$R=8,5\ \Omega$, $L=150\ \mu\text{H}$, and $C=0,01\ \mu\text{F}$~~ $R=8.5\ \Omega$, $L=150\ \mu\text{H}$, and $C=.022\ \mu\text{F}$. This will generate a 10 dB notch with a Q of ~~5~~ 4, centred at approximately ~~430 kHz~~ 88 kHz. The received signal strength is the voltage on the $50\ \Omega$ resistor of the V-network and is set by adjusting R1 when the transmitter is sending packets. The received PER% shall be less than 2 % when the received signal is -60 dBV (2,828 mVpp).

History

Document history		
V1.1.1	October 2011	Publication