SLOVENSKI STANDARD
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Stanovanjski in stavbni elektronski sistemi (HBES) - 5-1. del: Mediji in nivoji, odvisni od medijev - Napajalni vod za HBES razreda 1

Home and Building Electronic Systems (HBES) - Part 5-1: Media and media dependent layers - Power line for HBES Class 1

Elektrische Systemtechnik für Heim und Gebäude (ESHG) - Teil 5-1: Medien und medienabhängige Schichten - Signalübertragung auf elektrischen Niederspannungsnetzen für ESHG Klasse 1

Systèmes électroniques pour les foyers domestiques et les bâtiments (HBES) - Partie 5-1: Medias et couches dépendantes des medias - Courants porteurs pour HBES Classe 1

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CENELEC
European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 205, Home and Building Electronic Systems (HBES) with the help of CENELEC co-operation partner Konnex Association, Neerveldstraat 105, B-1200 Brussels, (former EHBESA).

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50090-5-1 on 2004-09-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2005-09-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2007-09-01

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EN 50090-5-1 is part of the EN 50090 series of European Standards, which will comprise the following parts:

Part 1: Standardization structure

Part 2: System overview

Part 3: Aspects of application

Part 4: Media independent layers

Part 5: Media and media dependent layers

Part 6: Interfaces

Part 7: System management

Part 8: Conformity assessment of products

Part 9: Installation requirements

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Contents

1 Scope

This European Standard defines the mandatory and optional requirements for the medium specific physical and data link layer of power line Class 1 in its two variations PL110 and PL132.

Data link layer interface and general definitions, which are medium independent, are given in EN 50090-4-1.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50090-1	- [1)]	*Home and Building Electronic Systems (HBES)* *Part 1: Standardization structure*
EN 50090-2-2	1996	*Home and Building Electronic Systems (HBES)* *Part 2-2: System overview - General technical requirements*
EN 50090-4-1	2004	*Home and Building Electronic Systems (HBES* *Part 4-1: Media independent layers - Application layer for HBES Class 1*
EN 50090-4-2	2004	*Home and Building Electronic Systems (HBES)* *Part 4-2: Media independent layers - Transport layer, network layer and general parts of data link layer for HBES Class 1*
EN 50090-5-2	2004	*Home and Building Electronic Systems (HBES) -* *Part 5-2: Media and media dependent layers - Network based on HBES Class 1, Twisted Pair*
EN 50065-1	2001	*Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kH* *Part 1: General requirements, frequency bands and electromagnetic disturbances*
EN 50065-4-6	2004	*Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz* *Part 4-6: Low voltage decoupling filters - Phase coupler*
EN 50065-7	2001	*Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kH* *Part 7: Equipment impedance*
EN 50160	1999	*Voltage characteristics of electricity supplied by public distribution systems*
EN 55016-1-2	2004	*Specification for radio disturbance and immunity measuring apparatus and methods* *Part 1-2: Radio disturbance and immunity measuring apparatus - Ancillary equipment - Conducted disturbances (*CISPR 16-1-2:2003)
EN 61643-11	2002	*Low-voltage surge protective devices – Part 11: Surge protective devices connected to low-voltage power systems - Requirements and tests (IEC 61643-1:1998 + corrigendum Dec. 1998, modified)*

[1)] At draft stage.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this part the terms and definitions given in EN 50090-1 (some of which are repeated below for convenience) and the following apply.

3.1.1
differential mode
PL signals are injected between phase and neutral [EN 50065-1]

3.1.2
router
a router connects one sub-network with another sub-network

3.1.3
PL110
power line signalling operating in the frequency band 95 kHz - 125 kHz according to EN 50065-1

3.1.4
PL132
power line signalling operating in the frequency band 125 kHz - 140 kHz according to EN 50065-1

3.2 Abbreviations

HBES Class 1	refers to simple control and command
HBES Class 2	refers to Class 1 plus simple voice and stable picture transmission
HBES Class 3	refers to Class 2 plus complex video transfers
ACK	Acknowledgement
NRZ	Non Return to Zero
SPD	Surge Protection Devices
LPDU	Link layer Protocol Data Unit
CS	Check Sequence
TPDU	Transport layer Protocol Data Unit
APDU	Application layer Protocol Data Unit
NACK	Not acknowledge
DAF	Destination Address Flag
FSK	Frequency Shift Keying
SFSK	Spread Frequency Shift Keying
MSK	Minimum Shift Keying
FEC	Forward Error Correction
FCS	Frame Check Sequence
CTRL	Control field
MAU	Medium Attachment Unit
NPCI	Network Protocol Control Information
CSMA	Carrier Sense Multiple Access protocol
DOA	Domain Address

4 Requirements for HBES Class 1, power line PL110

4.1 Physical layer PL110

4.1.1 General

This clause describes the physical layer characteristics of the PL110 power line signalling which operates in the frequency band 95-125kHz band as described in EN 50065-1 and having a nominal centre frequency of 110 kHz.

The main characteristics of the PL110 physical layer are:

- a spread frequency shift keying signalling;
- asynchronous transmission of data packets;
- symbols globally synchronized to the mains frequency;
- half duplex bi-directional communication.

Electrical wiring in the building/home shall be in compliance with the current national regulations. Power line communication is described in EN 50065-1 (general requirements, frequency allocation and electromagnetic disturbances).

The electric power distribution network normally determines the physical topology of the power line network. The structure of this network may be 1- or 3-phase. The rated voltage between one phase and the neutral shall be 230 V. PL110 signals are injected between phase and neutral.

General requirements for the physical layer type PL110 are given in Table 1.

Table 1 - General requirements for physical layer PL110

Characteristic	Description
Medium	electrical power distribution network
Topology	installation dependant (e.g. linear, star, tree)
Bit rate	1 200 bps
Mains frequency	50 Hz (according to EN 50160)
Number of Domain Addresses	255
Number of Individual Addresses	32 767
Modulation type	spread frequency shift keying (SFSK)
Frequency for logical “0“	105,6 kHz ± 100 ppm
Frequency for logical “1“	115,2 kHz ± 100 ppm
Bit duration	833,33 µs
Maximum output level	122 dBµV [a]
Input sensitivity	≤ 60 dBµV [b]
Device class	Class 122 [c]
Compliance to standards	EN 50065-1

[a] Measurement according to EN 50065-1.

[b] With artificial network according to EN 55016-1-2 [(50 µH + 5 Ω) / 50 Ω].

[c] Equipment manufactured to Class 116 according to EN 50065-1 will now meet the requirements of Class 122 and may be marked Class 116 provided that its output complies with the previous standard.

The logical structure of the physical layer PL110 entity is shown in Figure 1. Each PL110-device includes one.

The PL110 entity shall consist of three blocks:

- connector;
- medium attachment unit (MAU);
- error correction.

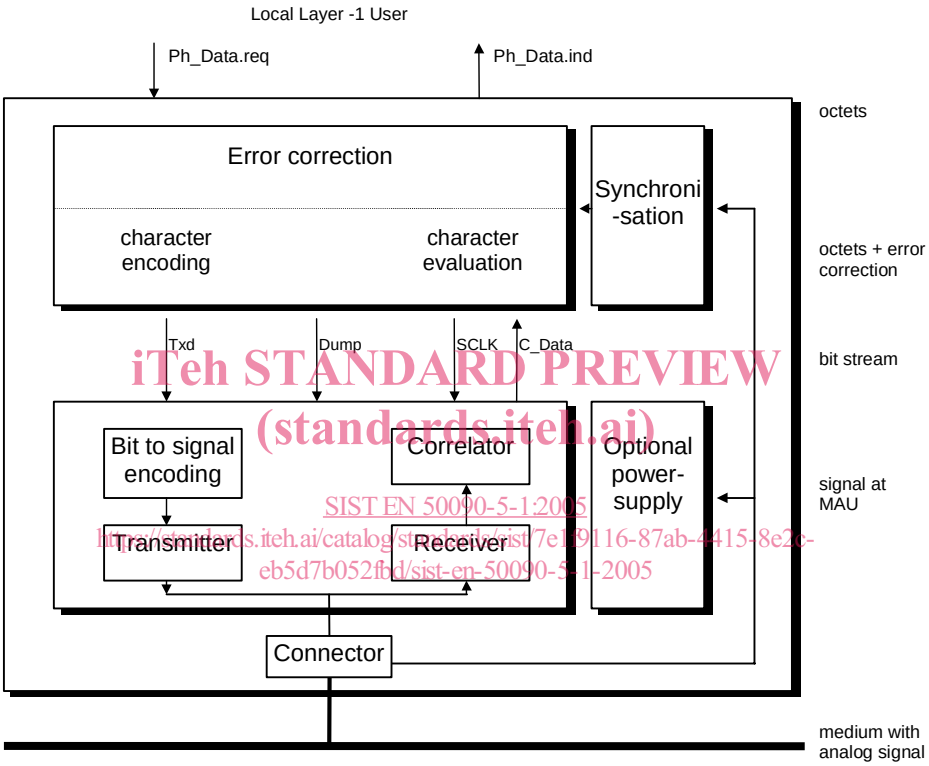


Figure 1 - Structure of the MAU (example)

4.1.2 Transmission medium

4.1.2.1 Requirements for protection against electrical shocks and connectors

The PL110 devices are connected to the 230 V installation network. The requirements for protection against electrical shocks for human beings (and animals) and connectors shall be considered within the complete device and are not subject to the physical layer description.

These requirements are fixed in the installation and equipment standards (safety standards).

4.1.2.2 Power line cables

The requirements for power line cables are defined by the use as installation wires according to national regulations. Normally the type of cable, the connected loads and the topology of the network is not known. Some widespread cables are listed in Table 2. In contrast to the theoretical values, the impedance at one network access point is determined more by the load than by the cabling.

Typical cables for fixed electrical installation are “thermoplastic-insulated and sheathed cable“, “PVC-insulated flat cable, overall covering vulcanized rubber“ or “sheathed metal-clad wiring cable with PVC-insulated cores sheet-zinc cover with additional PVC-jacket” .

Table 2 - Example of typical cable characteristics

Feature	Description
Cross-section	1,5 mm² up to 4 mm²
Used wires	Phase and Neutral
Resistance	25 µΩ/m to 50 mΩ/m
Capacity	15 pF/m to 100 pF/m
Inductance	1,2 µH/m to 1,5 µH/m

NOTE The use of shielded cables and cables with cross sections greater than 35 mm^2 can influence PL110 signalling significantly!

4.1.3 Medium attachment unit (MAU)

The medium attachment unit converts the frequency-coded signals into values representing logical ones and zeros and vice versa. In parallel, a power supply circuit may be connected to the medium. Signal converter and power supply shall be independent from each other. The power supply shall meet the following requirements:

Table 3 – Power supply of the MAU

Power supply	Nominal values
Receiving mode	5 V at 30 mA / 24 V at 1 mA
Transmitting mode	5 V at 30 mA / 24 V at 10 mA - 50 mA (dependent on impedance)

Compliance is checked by measurement.

The power supply of the MAU may be internal or external.

4.1.3.1 Signal encoding

A signal of 105,6 kHz for a period of $833.\overline{3}$ µs shall correspond to a logical “0“, a signal of 115,2 kHz for a period of $833.\overline{3}$ µs to a logical “1“. See Figure 2.

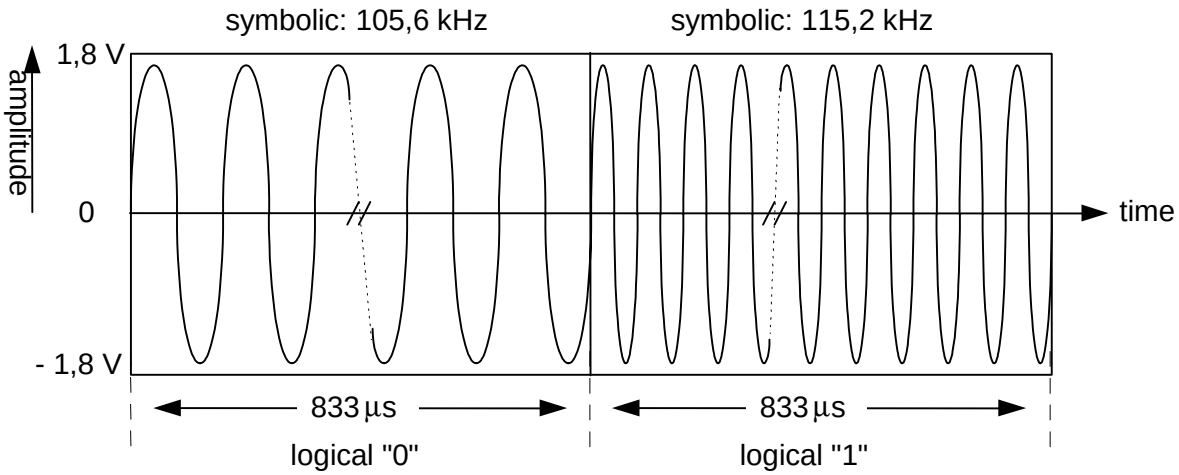


Figure 2 - Signal encoding

These NRZ-signals are superimposed on the 230 V/50 Hz mains AC-voltage. The maximum amplitude of the signal shall be limited to 122 dBµV, measured with EN 5506-1-2 artificial mains network according EN 50065-1. The sensitivity of the receiver shall be better than 60 dBµV.

For lowest disturbances, the change between adjacent symbols shall be phase continuous.

Compliance is checked by measurement.

4.1.3.2 Overlapping of logical "0" or "1"

Overlapping of logical "0" or "1"-symbols, e.g. the simultaneous transmission of equal information at the same time from several MAU's (e.g. common ACK), results in fade-in / fade-out effects. Due to slight frequency deviations between several MAU's the signal fades periodically with the difference of the MAU-frequencies. In PL110 power line communication this case can be avoided by setting a unique group response flag to each assigned Group Address.

4.1.3.3 Overlapping of logical "0" and "1"

Overlapping of logical "0" and "1"-symbols, e.g. the simultaneous transmission of different information at the same time from several MAU's, results in a collision. While there is no indication of collision for any MAU, the probability of this state is minimized by special bus access mechanism.

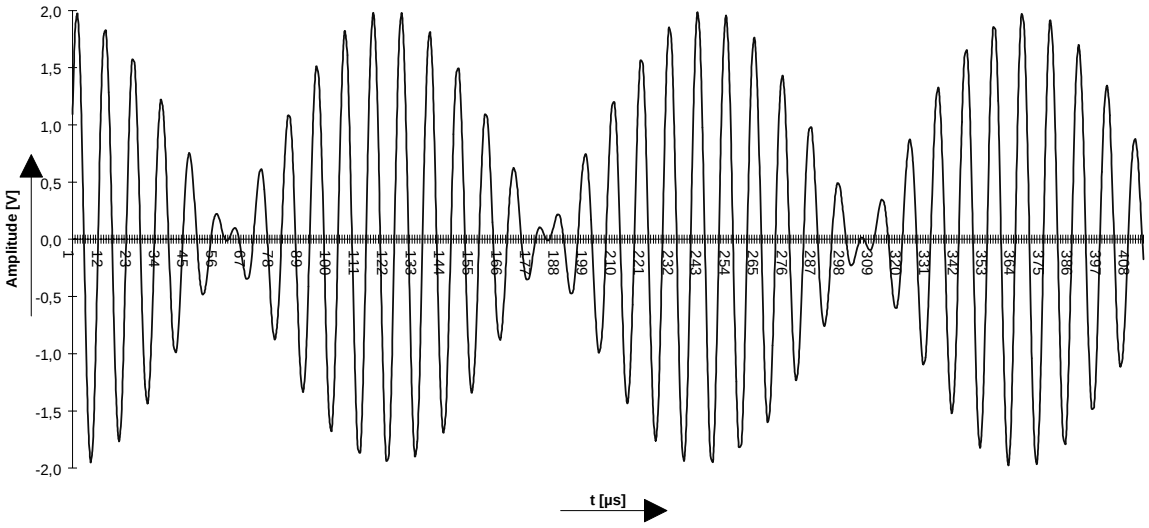


Figure 3 - Idealized overlapping of 105,6 kHz and 115,2 kHz

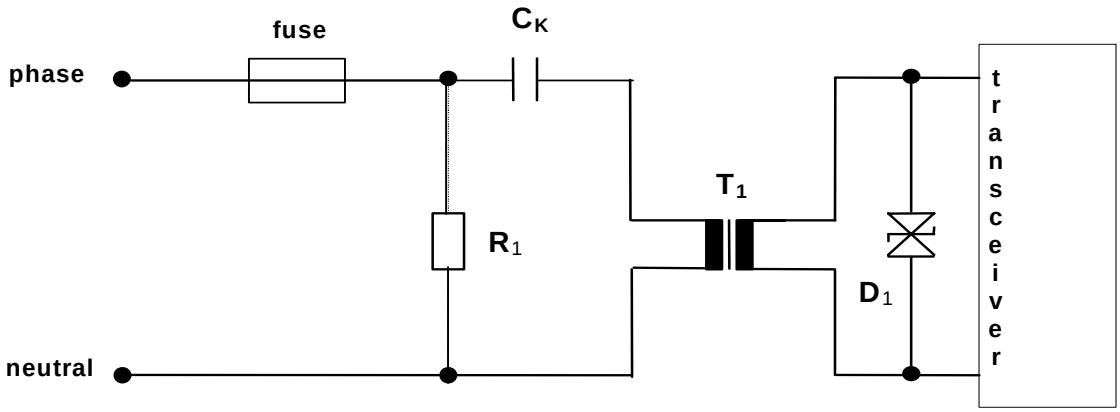
4.1.3.4 Impedance of the MAU

To limit the influence of connected MAU's on the characteristic of the power line bus the impedance in receiving mode shall be high. For signal injection with minimum losses, the impedance in transmitting mode shall be low. When tested according to EN 50065-7, the limits for PL110 shall be:

Table 4 - Requirements for the impedance of the MAU

Impedance on	Requirements
Receiving mode	$\lvert Z_{in} \rvert \geq 80\ \Omega$ at 100 kHz to 125 kHz
Transmitting mode	$\lvert Z_{out} \rvert \leq 20\ \Omega$ at 100 kHz to 125 kHz

4.1.3.5 PL bus coupling



Legend:
C_k: coupling capacitor, X2-type
T_1: coupling transformer
D_1: transient voltage protection diode
R_1: resistor for discharging C_k (optional)

Figure 4 - Example of a PL inductive coupling circuit

Electrical coupling of signals to the power line is done by special circuits. In general, capacitive or inductive coupling may be used. Inductive coupling may be combined with electrical insulation or not.

4.1.4 Installation topology

The structure of an electrical installation may be linear, star, ring, tree or any combination. Referring to the electrical distribution board as the centre, the topology normally has a star structure. Each branch of the electrical distribution network may have its own different structure.

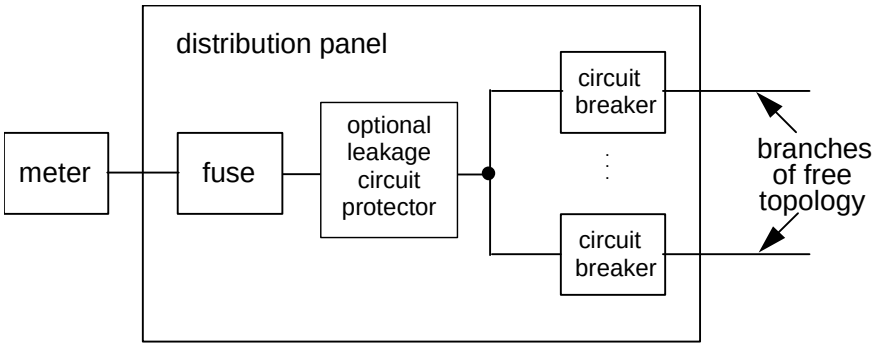


Figure 5 - Example of a typical PL topology

4.1.5 Installation requirements

The installation of the power line network is subject to national and international regulations and standards. Additional instructions about the communication aspects of the network may be given in the manufacturers instruction sheet.