INTERNATIONAL STANDARD

ISO/IEC 14543-3-5

First edition
2007-05

Information technology – Home electronic system (HES) architecture –

Part 3-5: Media and media dependent layers – Powerline for network based control of HES Class 1

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO/IEC 14543-3-5:2007
https://standards.iteh.ai/catalog/standards/sist/58cbaeec-51f9-47b9-80f2-a4a4261f9a4b/iso-iec-14543-3-5-2007

Reference number
ISO/IEC 14543-3-5:2007(E)

THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2007 ISO/IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about ISO/IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO/IEC 14543-3-5:2007
https://standards.iteh.ai/catalog/standards/sist/58cbaeec-51f9-47b9-80f2-a4a4261f9a4b/iso-iec-14543-3-5-2007

INTERNATIONAL STANDARD

ISO/IEC 14543-3-5

First edition
2007-05

Information technology – Home electronic system (HES) architecture –

Part 3-5: Media and media dependent layers – Powerline for network based control of HES Class 1

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO/IEC 14543-3-5:2007
https://standards.iteh.ai/catalog/standards/sist/58cbaeec-51f9-47b9-80f2-a4a4261f9a4b/iso-iec-14543-3-5-2007

PRICE CODE R

For price, see current catalogue

CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Terms, definitions and abbreviations 8
3.1 Terms and definitions 8
3.2 Abbreviations 8
4 Conformance 9
5 Requirements for HES Class 1, PL110 9
5.1 Physical Layer PL110 9
5.1.1 General 9
5.1.2 Transmission medium 10
5.1.3 Medium attachment unit (MAU) 11
5.1.4 Installation topology 13
5.1.5 Installation requirements 13
5.1.6 Surge protection 14
5.1.7 Services at the data link layer / physical layer interface 14
5.1.8 Features of PL110 physical layer 15
5.2 Data link layer type PL110 19
5.2.1 General 19
5.2.2 Domain address/individual address/group address 19
5.2.3 Frame formats 20
5.2.4 Medium access control 24
5.2.5 Data link layer services 28
5.2.6 Parameters of layer-2 30
5.2.7 Data link layer protocol 30
5.2.8 Layer-2 of a repeater 31
6 Requirements for HES Class 1, PL132 31
6.1 General 31
6.2 Physical layer PL132 32
6.2.1 Medium definition 32
6.2.2 Topology and medium 32
6.2.3 Datagram service 32
6.3 Data link layer type powerline 132 35
6.3.1 Frame format 35
6.3.2 Medium access control 40
6.3.3 L_Data Service and Protocol 41
6.3.4 L_PollData service 43
6.3.5 L_Busmon service 43
6.3.6 L_Service_Information service 43
Bibliography 44

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO/IEC 14543-3-5:2007
https://standards.iteh.ai/catalog/standards/sist/58cbaeec-51f9-47b9-80f2-a4a4261f9a4b/iso-iec-14543-3-5-2007

Figure 1 – Structure of the MAU (example) 10
Figure 2 – Signal encoding 11
Figure 3 – Idealised overlapping of 105,6 kHz and 115,2 kHz 12
Figure 4 – Example of a PL inductive coupling circuit 13
Figure 5 – Example of a typical PL topology 13
Figure 6 – Character 15
Figure 7 – Structure of a datagram 15
Figure 8 – Structure of an acknowledgement frame 16
Figure 9 – Generation matrix of PL110 16
Figure 10 – Operations of Galois Field GF2 17
Figure 11 – Three phase system (example for 50 Hz) 18
Figure 12 – Domain Address 19
Figure 13 – Individual Address 19
Figure 14 – Group Address 20
Figure 15 – Format 1s, frame fields with standard fieldname abbreviations 20
Figure 16 – Format 1s, L_Data_Standard request frame format 21
Figure 17 – Control field 21
Figure 18 – Check octet 22
Figure 19 – Frame fields with standard fieldname abbreviations 22
Figure 20 – Format 1e, L_Data_Extended request frame format 23
Figure 21 – Extended control field 23
Figure 22 – Format 2, short acknowledgement frame format 24
Figure 23 – Timing diagram of an L_Data-request frame 27
Figure 24 – Complete frame encapsulation (Datagram) 34
Figure 25 – Overview of primitives 34
Figure 26 – Frame fields with standard fieldname abbreviations 36
Figure 27 – L_Data request standard frame format 36
Figure 28 – Control field 36
Figure 29 – NPCI field 37
Figure 30 – Frame fields with standard fieldname abbreviations 38
Figure 31 – L_Data_ Extended request frame format 38
Figure 32 – Extended control field 39
Figure 33 – Data field in positive Acknowledgement Frame (ACK) 40
Figure 34 – Complete Acknowledgement Frame Encapsulation (ACK) 40

Table 1 – General requirements for physical layer PL110 9
Table 2 – Power supply of the MAU 11
Table 3 – Requirements for the impedance of the MAU 12
Table 4 – Table of syndromes related to errors 17
Table 5 – L_Data-request priorities 26
Table 6 – Parameters for Ph-Data service 34
Table 7 – Ph-Service class parameters 35
Table 8 – Ph-Result values 35

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO/IEC 14543-3-5:2007
https://standards.iteh.ai/catalog/standards/sist/58cbaeec-51f9-47b9-80f2-a4a42e61b9a4/iso-iec-14543-3-5-2007

INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) ARCHITECTURE –

Part 3-5: Media and media dependent layers – Powerline for network based control of HES Class 1

FOREWORD

1) ISO (International Organization for Standardization) and IEC (International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards. Their preparation is entrusted to technical committees; any ISO and IEC member body interested in the subject dealt with may participate in this preparatory work. International governmental and non-governmental organizations liaising with ISO and IEC also participate in this preparation.

2) In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

3) The formal decisions or agreements of IEC and ISO on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC and ISO member bodies.

4) IEC, ISO and ISO/IEC Publications have the form of recommendations for international use and are accepted by IEC and ISO member bodies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC, ISO and ISO/IEC Publications is accurate, IEC or ISO cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

5) In order to promote international uniformity, IEC and ISO member bodies undertake to apply IEC, ISO and ISO/IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any ISO/IEC Publication and the corresponding national or regional publication should be clearly indicated in the latter.

ISO/IEC 14543-3-5:2007
https://standards.iteh.ai/catalog/standards/sist/58cbaeec-51f9-47b9-80f2-a4a426119a4b/iso-iec-14543-3-5-2007

6) ISO and IEC provide no marking procedure to indicate their approval and cannot be rendered responsible for any equipment declared to be in conformity with an ISO/IEC Publication.

7) All users should ensure that they have the latest edition of this publication.

8) No liability shall attach to IEC or ISO or its directors, employees, servants or agents including individual experts and members of their technical committees and IEC or ISO member bodies for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication of, use of, or reliance upon, this ISO/IEC publication or any other IEC, ISO or ISO/IEC publications.

9) Attention is drawn to the normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

IEC and ISO draw attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning an efficient implementation of synchronization, see 5.1.8.7.

Busch-Jaeger has informed IEC and ISO that they have the granted patent EP 0856954.

IEC and ISO draw attention to the fact that it is claimed that compliance with this document may involve the use of a patent in case specific notch configurations are implemented.

Zumtobel has informed IEC and ISO that they have the granted patent DE 29701412.

ISO and IEC take no position concerning the evidence, validity and scope of these putative patent rights. The holders of these putative patent rights have assured IEC and ISO that they are willing to negotiate free licences or licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statements of the holders of these putative patent rights are registered with IEC and ISO. Information may be obtained from:

Busch-Jaeger Freisenbergstraße 2 D-58513 Lüdenscheid Germany	Zumtobel Staff GmbH Schweizerstrasse 30 A-6850 Dornbirn Austria

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC and ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 14543-3-5 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

This International Standard is a product family standard. It shall be used in conjunction with ISO/IEC 14543-2-1, 14543-3-1, 14543-3-2, 14543-3-3, 14543-3-4, 14543-3-6 and 14543-3-7.

The list of all currently available parts of the ISO/IEC 14543 series, under the general title *Information technology – Home electronic system (HES) architecture,* can be found on the IEC web site.

This International Standard has been approved by vote of the member bodies, and the voting results may be obtained from the address given on the second title page.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO/IEC 14543-3-5:2007
https://standards.iteh.ai/catalog/standards/sist/58cbaeec-51f9-47b9-80f2-a4a4261f9a4b/iso-iec-14543-3-5-2007

INTRODUCTION

The Reference model for Open System Interconnection (OSI), specified in ISO/IEC 7498, assigns the functions that are needed for communications between two entities that are connected by a medium to seven logical layers. This International Standard specifies interconnection of entities used for home and building control via the medium powerline. It specifies the medium dependent functions, that is the mains characteristics and the transmission technology in terms of the Physical Layer and the Data Link Layer, according to ISO/IEC 7498.

Currently, ISO/IEC 14543, *Information technology – Home Electronic System (HES) architecture*, consists of the following parts:

Part 2-1: *Introduction and device modularity*
Part 3-1: *Communication layers – Application layer for network based control of HES Class 1*
Part 3-2: *Communication layers – Transport, network and general parts of data link layer for network based control of HES Class 1*
Part 3-3: *User process for network based control of HES Class 1*
Part 3-4: *System management – Management procedures for network based control of HES Class 1*
Part 3-5: *Media and media dependent layers – Powerline for network based control of HES Class 1*
Part 3-6: *Media and media dependent layers – Twisted pair for network based control of HES Class 1*
Part 3-7: *Media and media dependent layers – Radio frequency for network based control of HES Class 1*
Part 4: *Home and building automation in a mixed-use building (technical report)*
Part 5-1: *Intelligent grouping and resource sharing for HES Class 2 and Class 3 – Core protocol (under consideration)*
Part 5-2: *Intelligent grouping and resource sharing for HES Class 2 and Class 3 – Device certification (under consideration)*

Additional parts may be added at a later date.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO/IEC 14543-3-5:2007
https://standards.iteh.ai/catalog/standards/sist/58cbaeec-51f9-47b9-80f2-a4a4261f9a4b/iso-iec-14543-3-5-2007

INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) ARCHITECTURE –

Part 3-5: Media and media dependent layers – Powerline for network based control of HES Class 1

1 Scope

This part of ISO/IEC 14543 defines the mandatory and optional requirements for the medium specific Physical and Data Link Layer of Powerline Class 1 in its two variations PL110 and PL132.

NOTE Data Link Layer interface and general definitions, which are medium independent, are given in ISO/IEC 14543-3-1.

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.

ISO/IEC 14543-2-1, *Information technology – Home Electronic System (HES) architecture – Part 2-1: Introduction and device modularity*

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/IEC 14543-3-1, *Information technology – Home Electronic System (HES) architecture – Part 3-1: Communication layers – Application layer for network based control of HES Class 1*

ISO/IEC 14543-3-5:2007
https://standards.iteh.ai/catalog/standards/sist/76cbdaec-5119-4765-80f2-a4a420119a40/iso-iec-14543-3-5-2007

ISO/IEC 14543-3-2, *Information technology – Home Electronic System (HES) architecture – Part 3-2: Communication layers – Transport, network and general parts of data link layer for network based control of HES Class 1*

ISO/IEC 14543-3-3, *Information technology – Home Electronic System (HES) architecture – Part 3-3: User process for network based control of HES Class 1*

ISO/IEC 14543-3-4, *Information technology – Home Electronic System (HES) architecture – Part 3-4: System management – Management procedures for network based control of HES Class 1*

ISO/IEC 14543-3-6, *Information technology – Home Electronic System (HES) architecture – Part 3-6: Media and media dependent layers – Twisted pair for network based control of HES Class 1*

ISO/IEC 14543-3-7, *Information technology – Home Electronic System (HES) architecture – Part 3-6: Media and media dependent layers – Radio frequency for network based control of HES Class 1*

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*

EN 50065-1, *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*

EN 50065-7, *Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz – Part 7: Equipment impedance*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this International Standard the definitions given in ISO/IEC 14543-2-1 (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

3.1.2
router
connects one sub-network to another sub-network

3.1.3
PL110
powerline signalling operating in a frequency band of 95 kHz to 125 kHz according to EN 50065-1

3.1.4
PL132
powerline signalling operating in a frequency band of 125 kHz to 140 kHz according to EN 50065-1

iTeh STANDARD PREVIEW
(standards.iteh.ai)

3.2 Abbreviations

ISO/IEC 14543-3-5:2007
https://standards.iteh.ai/catalog/standards/sist/58cbaeec-51f9-47b9-80f2-a4a4261f9a4b/iso-iec-14543-3-5-2007

ACK	acknowledgement
APDU	Application Layer Protocol Data Unit
CS	Check Sequence
CSMA	Carrier Sense Multiple Access protocol
CTRL	Control field
DAF	Destination Address Flag
DOA	Domain Address
FCS	Frame Check Sequence
FEC	Forward Error Correction
FSK	Frequency Shift Keying
HES Class 1	refers to simple control and command
HES Class 2	refers to Class 1 plus simple voice and stable picture transmission
HES Class 3	refers to Class 2 plus complex video transfers
LPDU	Link Layer Protocol Data Unit
MAU	Medium Attachment Unit
MSK	Minimum Shift Keying
NACK	Not acknowledge
NPCI	Network Protocol Control Information
NRZ	No Return to Zero
PL	Powerline
SPD	Surge Protection Devices
TPDU	Transport Layer Protocol Data Unit
SFSK	Spread Frequency Shift Keying

4 Conformance

A device conforming to this International Standard shall support the physical medium as specified in clause 5 or clause 7, and it shall provide transmission capability as specified in clause 6.

5 Requirements for HES Class 1, PL110

5.1 Physical Layer PL110

5.1.1 General

This clause describes the physical layer characteristics of the PL110 powerline signalling which operates in the frequency band (95 to 125) kHz band as described in EN 50065-1 and which has a nominal centre frequency of 110 kHz.

The main characteristics of PL110 physical layer are:

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

Electrical wiring in the building/home shall be in compliance with the current national regulations. Powerline communication is described in EN 50065-1.

iTeh STANDARD PREVIEW

The electric power distribution network normally determines the physical topology of the powerline network. The structure of this network may be single phase or three phase. The rated voltage between one phase and neutral shall be 110 V and 230 V, respectively. PL110 signals are injected between phase and neutral.

(standards.iteh.ai)
ISO/IEC 14543-3-5:2007
https://standards.iteh.ai/catalog/standards/sist/58cbaeec-51f9-47b9-80f2-

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

Table 1 – General requirements for physical layer PL110

Characteristics	Description
Medium	Electrical power distribution network
Topology	Installation dependant (e.g., linear, star, tree)
Bit rate	1 200 bit/s
Mains frequency	50 Hz and 60 Hz, respectively
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 ± 0,1%
Frequency for logical 1	115,2 kHz ± 0,1%
Bit duration	833,3 µs
Maximum output level	122 dB µV [a]
Input sensitivity	≤60 dB µV [b]
Device class	Class 122[c]
Compliance to standards	EN 50065-1

[a] Measurement according to EN 50065-1.

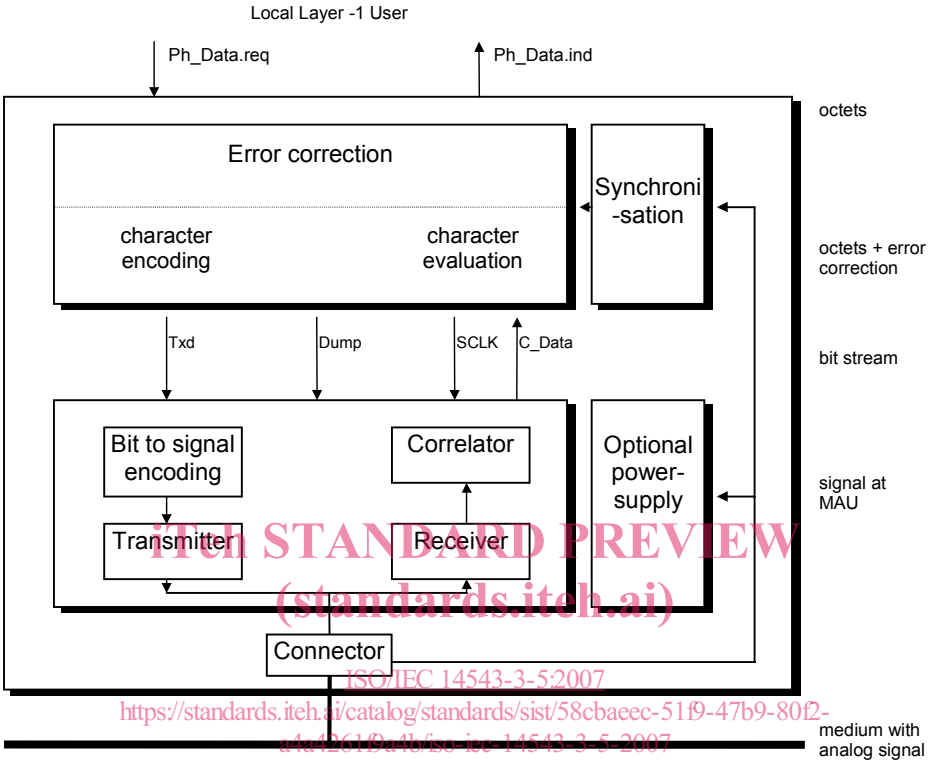
[b] With artificial network according to CISPR 16-1-1 [(50 µH + 5 Ω) / 50 Ω].

[c] Equipment manufactured in accordance with 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 physical layer PL110 entity.

The PL110 entity shall consist of three blocks:

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



iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO/IEC 14543-3-5:2007
https://standards.iteh.ai/catalog/standards/sist/58cbaeec-51f9-47b9-80f2-a4a4261fba4b/iso-iec-14543-3-5-2007

Figure 1 – Structure of the MAU (example)

5.1.2 Transmission medium

5.1.2.1 Requirements for protection against electric shocks and connectors

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

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

5.1.2.2 Powerline cables

The requirements for powerline 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. In contrast to the theoretical values of typical cable characteristics, for example as specified in IEC 60227-4 and IEC 60502-1, the impedance at one network access point is determined more by the connected load than by the cabling.

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

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

5.1.3 Medium attachment unit (MAU)

The Medium Attachment Unit converts the frequency-coded signals into values representing logical ones and zeroes 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 requirements specified in Table 2.

Table 2 – 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.

5.1.3.1 Signal encoding

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

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO/IEC 14543-3-5:2007
https://standards.iteh.ai/catalog/standards/sist/58cbaeec-51f9-47b9-80f2-a4a4261f9a4b/iso-iec-14543-3-5-2007

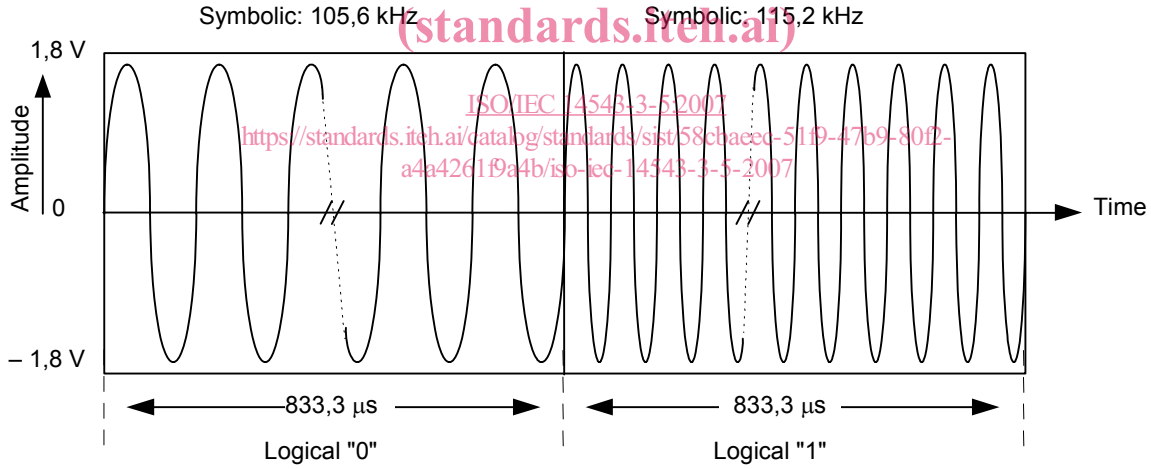


Figure 2 – Signal encoding

These NRZ signals are superimposed on the AC voltage of the mains at 50 Hz and 60 Hz, respectively. The maximum amplitude of the signal shall be limited to 122 dBµV, measured according to EN 50065-1 by using an artificial mains network as specified in CISPR 16-1-1. The sensitivity of the receiver shall exceed 60 dBµV.

For minimal disturbance, the change between adjacent symbols shall be phase continuous, as shown in Figure 2.

Compliance is checked by measurement.

5.1.3.2 Overlapping of logical 0 or 1

Overlapping of logical 0 or 1 symbols, for example, the simultaneous transmission of equal information at the same time from several MAUs (e.g., common ACK), results in fade-in / fade-out effects. Due to slight frequency deviations between several MAUs, the signal fades