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FAST-TRACK PROCEDURE

Open Data Communication in Building Automation, Controls and Building Management — Control Network Protocol —

Part 2:
Twisted Pair Communication

Communication de données ouverte en immotique, contrôles et gestion d'immeuble — Protocole de réseau de contrôle —

Partie 2: Communication de paire torsadée

ICS 35.200; 35.240.99

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NOTE FROM ITTF

This draft International Standard is submitted for JTC 1 national body vote under the Fast-Track Procedure.

In accordance with Resolution 30 of the JTC 1 Berlin Plenary 1993, the proposer of this document recommends assignment of ISO/IEC 14908-2 to JTC 1/SC 25.

"FAST-TRACK" PROCEDURE

1 Any P-member and any Category A liaison organization of ISO/IEC JTC 1 may propose that an existing standard from any source be submitted directly for vote as a DIS. The criteria for proposing an existing standard for the fast-track procedure are a matter for each proposer to decide.

2 The proposal shall be received by the ITTF which will take the following actions.

2.1 To settle the copyright and/or trade mark situation with the proposer, so that the proposed text can be freely copied and distributed within JTC 1 without restriction.

2.2 To assess in consultation with the JTC 1 secretariat which SC is competent for the subject covered by the proposed standard and to ascertain that there is no evident contradiction with other International Standards.

2.3 To distribute the text of the proposed standard as a DIS. In case of particularly bulky documents the ITTF may demand the necessary number of copies from the proposer.

3 The period for combined DIS voting shall be six months. In order to be accepted the DIS must be supported by 75 % of the votes cast (abstention is not counted as a vote) and by two-thirds of the P-members voting of JTC 1.

4 At the end of the voting period, the comments received, whether editorial only or technical, will be dealt with by a working group appointed by the secretariat of the relevant SC.

5 If, after the deliberations of this WG, the requirements of 3 above are met, the amended text shall be sent to the ITTF by the secretariat of the relevant SC for publication as an International Standard.

If it is impossible to agree to a text meeting the above requirements, the proposal has failed and the procedure is terminated.

In either case the WG shall prepare a full report which will be circulated by the ITTF.

6 If the proposed standard is accepted and published, its maintenance will be handled by JTC 1.

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Foreword

This European Standard (EN 14908-2:2005) has been prepared by CEN /TC 247, "Building Automation, Controls and Building Management", the secretariat of which is held by SNV.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2006, and conflicting national standards shall be withdrawn at the latest by April 2006.

This European Standard supersedes ENV 13154—2:1998.

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This European Standard is part of a series of standards for open data transmission in building automation, control and in building management systems. The content of this European Standard covers the data communications used for management, automation/control and field functions.

EN 14908-2 is part of a series of European Standards under the general title *Control Network Protocol (CNP)*, which comprises the following parts:

Part 1: *Protocol Stack*[1]

Part 2: *Twisted Pair Communication*[1]

Part 3: *Power Line Channel Specification*[1]

Part 4: *IP-Communication*[1]

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

[1] Under preparation.

[1] Under preparation.

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Introduction

This European Standard has been prepared to provide mechanisms through which various vendors of building automation, control, and building management systems may exchange information in a standardised way. It defines communication capabilities.

This European Standard is to be used by all involved in design, manufacture, engineering, installation and commissioning activities.

This European Standard has been made in response to the essential requirements of the Constructive Products Directive.

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1 Scope

This European Standard specifies the control network protocol (CNP) free-topology twisted-pair channel and serves as a companion European Standard to prEN14908-1. The channel supports communication at 78,125 kbps between multiple nodes, each of which consists of a transceiver, a protocol processor, an application processor, a power supply, and application electronics.

This European Standard covers the complete physical layer (OSI Layer 1), including the interface to the Media Access Control (MAC) sub-layer and the interface to the medium. Parameters that are controlled by other layers but control the operation of the physical layer are also specified.

2 Normative References

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

EN 14908-1:2005, *Open Data Communication in Building Automation, Controls and Building Management - Building Network Protocol - Part 1: Protocol Stack.*

EN 50173-1, *Information technology - Generic cabling systems- Part 1: General requirements and office areas*

3 Network Overview

The CNP free-topology twisted-pair channel supports up to 128 nodes on a single network segment with an optional link power source that supplies DC power to the nodes on the network. The channel is specified to support free-topology wiring, and will accommodate bus, star, loop, or any combination of these topologies. The total network length and number of nodes may be extended by use of CNP channel physical layer repeaters, or CNP compliant routers. The channel data rate is 78,125 kbps. Nodes can be either locally powered or link powered. A link-powered node derives its power from the network. The power is delivered on the same two conductors that carry data. Nodes are polarity-insensitive with respect to data as well as DC power. A locally powered node derives its power from a local source. The data is transmitted using Differential Manchester encoding, which is polarity-insensitive.

4 System Specifications

4.1 General Aspects

This section specifies the cable type used, terminations required with bus or free topology, maximum node counts and distances for link and locally powered schemes, and the maximum steady state power that can be drawn from the link power supply.

4.2 Cable

The cable shall conform to EN 50173-1.

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4.3 Topology

4.3.1 Free or Bus Topology

The network may use either a singly-terminated free topology or a doubly-terminated bus topology.

4.3.2 Repeater

Two network segments may be interconnected with a channel physical layer repeater. No more than one physical layer repeater shall be in a path between any two nodes on a network. Physical layer repeaters shall not be interconnected in such a way as to create a loop.

Each port of a physical layer repeater shall meet the specifications stated in 6.2, 6.3.3, and 6.4. The delay through the repeater shall not exceed 36 µs.

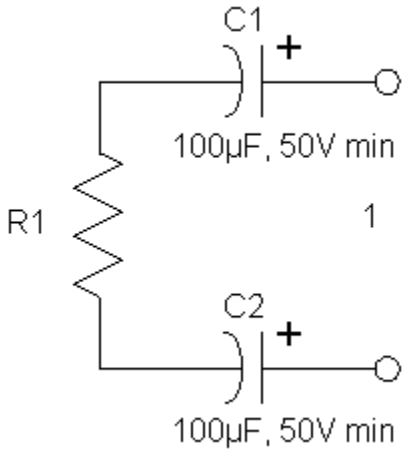
4.4 Cable Termination

4.4.1 Free-topology Segment

A free-topology segment shall have a single termination. If the segment is locally powered, an RC network as shown in Figure 1 shall be used, with R1 = 52,3 Ω ± 1 %, 1/8 W. The termination may be located anywhere on the segment. If the segment is link-powered, the termination shall be provided by the link power source. See Figure 5. The link power source and termination may be located anywhere on the segment.

4.4.2 Bus Topology Segment

A bus topology segment shall have two terminations, one at each end of the bus. If the segment is locally powered, an RC network as shown in Figure 1 shall be used, with R1 = 105 Ω ± 1 %, 1/8 W at each end. If the segment is link-powered, the link power source shall provide one termination. See Figure 5. The other termination shall be an RC network as shown in Figure 1, with R1 = 105 Ω ± 1 %, 1/8 W.



Key
1 Network Connection

Figure 1 — Termination

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4.5 Segment Configuration

A free-topology twisted-pair channel shall support up to 128 link-powered or 64 locally-powered nodes at a maximum bit error rate of 1 in 100 000. Both types of nodes shall be supported on a given segment, provided the following constraint is met:

$$(1 \times \text{number of link powered nodes}) + (2 \times \text{number of locally powered nodes}) \leq 128$$

Table 1 shows the maximum bus length for a bus-topology segment.

Table 2 shows the maximum node-to-node distance and maximum wire length for a free-topology segment. The distance from each node to each of the other nodes and to the link power source shall not exceed the maximum node-to-node distance. If multiple paths exist, e.g., a loop topology, then the longest path shall be used for the calculations. The maximum wire length is the total amount of wire connected to a network segment.

Table 1 — Bus-Topology Distance Specifications

Maximum Bus Length	Maximum Stub Length	Units
600	3	meters

Table 2 — Topology Distance Specifications

Maximum Node-to-node Distance	Maximum Total Wire length	Units
250	450	metres

4.6 Power Specifications

The sum of the steady-state power drawn by all nodes on a segment shall not exceed 36,5 watts. For each branch, the sum of the products of each node's distance multiplied by that node's power shall not exceed a constant:

$$P_1 \times d_1 + P_2 \times d_2 + P_3 \times d_3 + \ldots \leq C \times \alpha \quad (1)$$

where

- C is a constant, dependent on wire type, taking into account manufacturing tolerance and all other variations except wire temperature;
- C = 1,9 x 10^3 watt-meters;
- P_i = Node power, i.e., the maximum steady-state power drawn by node ‘i’ from the network, in watts;
- d_i = Node distance, i.e., the distance of node ‘i’ from the link power source, in meters;
- α = 1/(1 + 0,00393 * (temp - 25°C)), accounting for average wire temperature.

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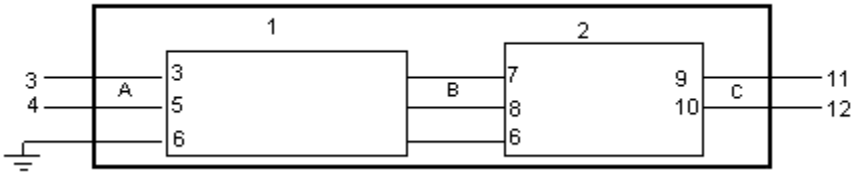
5 Link Power

5.1 General

A link-powered node derives its power from the network. The power is delivered on the same two conductors that carry data.

5.2 Source

The link power source shall consist of a passive coupler together with a power supply having special attributes. The requirements for the power supply for proper system operation include its start-up behaviour, tolerance to direct shorts across its output, and output voltage regulation. A schematic for the coupler is also included. The combination coupler/power supply block diagram is shown in Figure 2. Any deviations from the power supply requirements and coupler schematic (Figure 5) are allowed provided that the link power source design is electrically equivalent.



Key
1 Power Supply
2 Coupler
3 Line
4 Input
5 Neutral
6 Earth
7 Vin +
8 Vin –
9 Net +
10 Net –
11 Network
12 Output

Figure 2 — Link Power Source

The differential DC output voltage of the link power source shall be 41,0 VDC – 42,4 VDC over full operating conditions. Under normal (non-fault) conditions, the link power source shall "centre" the output voltage with respect to earth ground, resulting in +21 V and –21 V outputs at "Net+" and "Net-" respectively. The link power source shall recover after a continuous direct short across the output and shall properly restart the link powered network.

An earth reference terminal is required if the coupler is not grounded via the power supply.

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5.3 Power Supply Requirements

Unless otherwise specified, the power supply specifications in Table 3 shall be met over all combinations of the following conditions:

— Specified coupling circuit connected

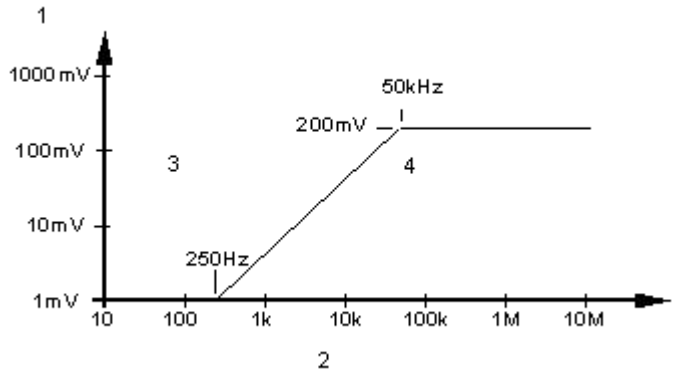
— Line input voltage over full range per specification

— Network output load = 0 to 1,5 DC amperes

Table 3 — Power Supply Requirements

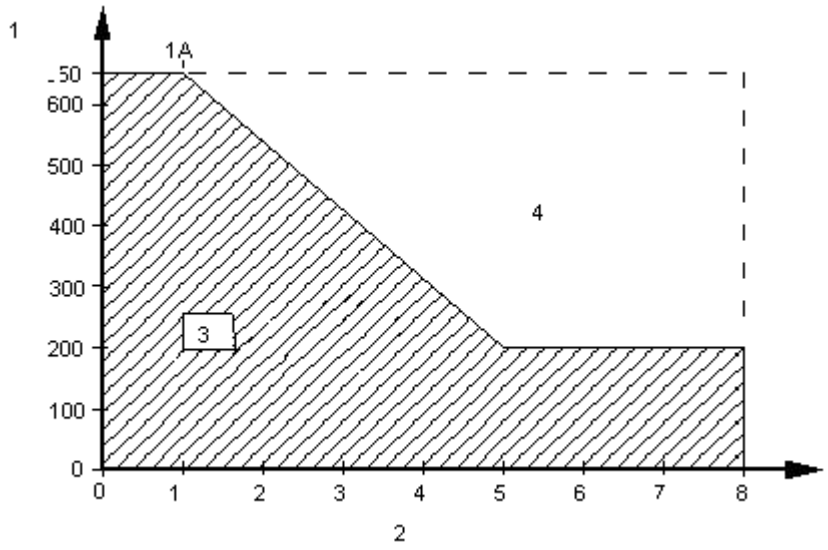
Description	Conditions	Specification
Line input voltage & indicator	• Measured at "A" (see Figure 2)	Line voltage as required by application environment. Input Power Applied indicator required - LED or equivalent.
Output voltage	• Measured at "B" (see Figure 2)	42,4 VDC maximum 42,08 VDC minimum
Output voltage regulation response	• Measured at "B" • 50 % step change in load	Output voltage must recover to within 1 % of its final value in less than 1ms of step change in load.
Output reference	• Measured at "B" • Coupling circuit disconnected	Floating with respect to earth.
Output ripple voltage (Differential)	• Measured at "B"	Reference Figure 2.
Spike noise (Differential)	• Measured at "B" • 50 MHz bandwidth	400 mV peak-to-peak maximum.
Output common-mode noise	• Measured at "B" with respect to earth	100 mV peak-to-peak maximum.
Continuous output current capability	• Measured at "B"	0 - 1,5 ADC
Output start-up interval behaviour	• Start-up or recovery from output short circuit or over-current fault • Measured at "B"	Reference Figure 4.
Short circuit output protection	• Continuous short circuit at output for any duration	Must recover after fault is cleared according to "Output start-up interval behaviour" specification.
Single fault tolerance	• Any single component failure as open or short • Measured at "B"	"Vin+" - "Vin-" ≤ 42,4V. |"Vin+" to earth| ≤ 42,4V. |"Vin-" to earth| ≤ 42,4V.

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Key
1 Peak to Peak Ripple Voltage (mV)
2 Ripple Frequency (Hz)
3 Unacceptable Ripple Level
4 Acceptable Ripple

Figure 3 — Power Supply Output Ripple Voltage Requirement



Key
1 On-time (milliseconds)

NOTE 1 On-time is defined as the time for the source power supply to charge the network from 0 V to 42 VDC for a given average output current.

2 $I_{average}$(Ampheres)

NOTE 2 $I_{average}$ is the average output current available from the source power supply when charging the network from 0 V to 42 VDC. Once the output voltage has reached 42 V, the output current capability must be at least 1,5 amperes.

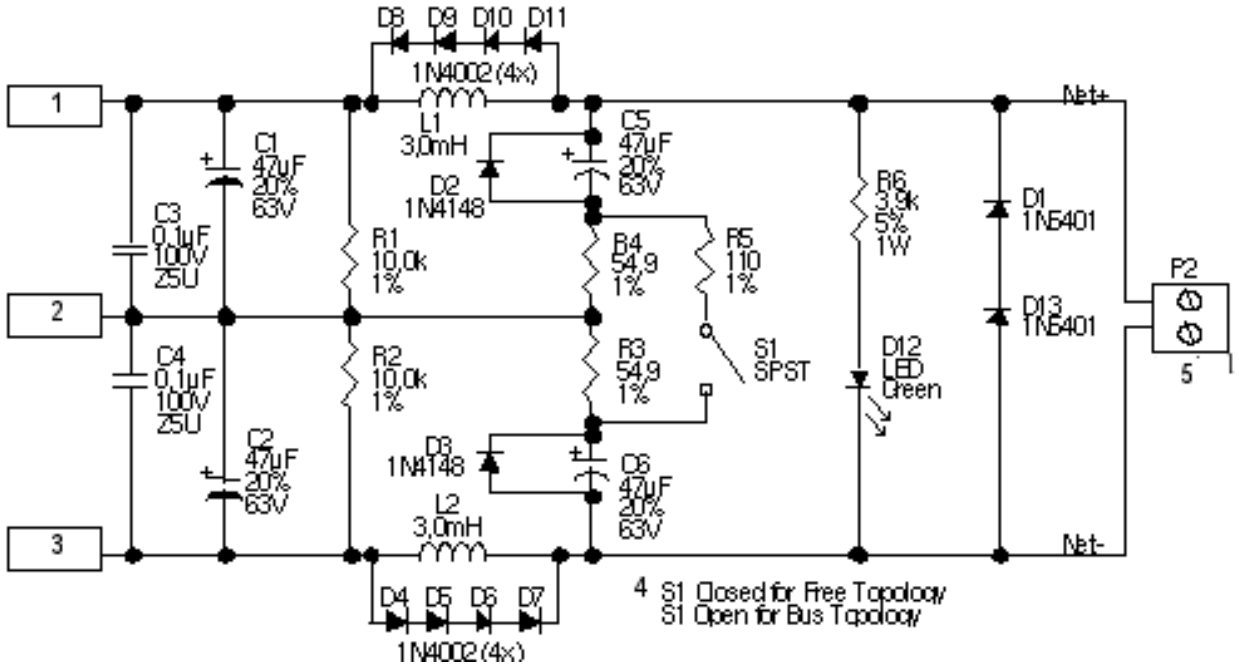
3 Unacceptable
4 Acceptable

Figure 4 — Power Supply Startup Interval Behavior

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5.4 Passive Coupler Circuit

A circuit according to the schematic shown in Figure 5,or any other circuit with equivalent performance, may be used. Table 4 shows the bill of materials corresponding to Figure 5.



Key

1 VIN +
2 EARTH
3 VIN –
4 S1 Closed for Free Topology
S1 Open for Bus Topology
5 Terminal Block

Figure 5 — Coupler Circuit Schematic

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Table 4 — Coupler Circuit Bill of Materials

Item	Quantity	Reference	Description
1	4	C1, C2, C5, C6	Capacitor, Aluminium Electrolytic, 47 µF, ± 20 %, 63 V
2	2	C3, C4	Capacitor, Ceramic, 0,1 µF, 100 V, Z5U dielectric or better
3	2	D1, D13	Diode, 1N5401, 3 A, 100 V
4	2	D2, D3	Diode, 1N4148 or equivalent
5	8	D4, D5, D6, D7, D8, D9, D10, D11	Diode, 1N4002, 1 A, 100 V
6	1	D12	LED, Green
7	2	L1, L2	Inductor, 3,0 mH, Ferrite Core, 1,5 A, RDC ≤ 0,36 Ω.
8	1	P2	Terminal block, 2-conductor, accepts conductor size AWG 24 - 14 (0,5 mm - 2,05 mm)
9	2	R1, R2	10,0 kΩ, ± 1 %, ¼ W
10	2	R3, R4	54,9 Ω, ± 1 %, ¼ W
11	1	R5	110 Ω, ± 1 %, ¼ W
12	1	R6	3,9k Ω, ± 5 %, 1 W
13	1	S1	Switch, SPST or equivalent jumper

6 Node Specifications

6.1 Link Power

A Link Power Unit Load (LPUL) is defined to be 285 mW drawn from the network. A node may consume multiple LPULs. A maximum of 128 LPUL's is allowed on the network. A link-powered node shall meet the requirements of Table 5.

Table 5 — Link Power Requirements

Parameter	Value	Unit
Maximum charge storage per LPUL	4,7	mA-seconds
Application power holdoff minimum delay on network power-up after network voltage exceeds 26 V	220	ms
Network DC voltage over which node shall be operational	26 to 42,4	V
Maximum network DC voltage below which node application power is shut off	24	V

6.2 Hot Plugging

A node shall sustain no hard failure and start up successfully when plugged into a powered network.

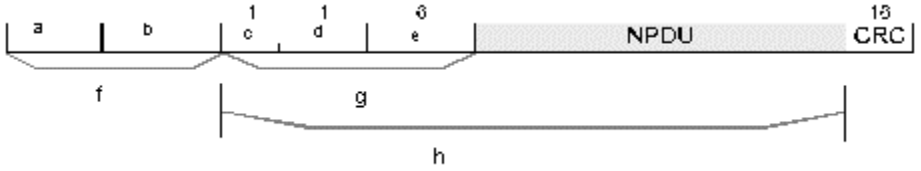
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6.3 Transmitter/Receiver Interface to the MAC Sub-Layer

6.3.1 Physical Layer Protocol Data Unit

The physical layer shall interface with the MAC sub-layer according to the service interface defined in 6.3, 6.4 and 6.5 of EN 14908-1:2005. Figure 6 shows the physical layer protocol data unit (PPDU).

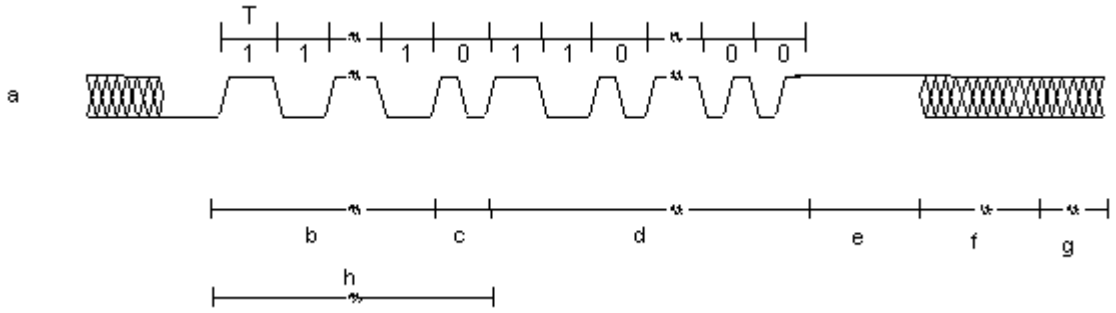


Key
a BitSync
b ByteSync
c Prior
d AltPath
e Delta_BL
f Preamble
g Layer 2 Header
h Data

Figure 6 — Physical Layer Protocol Data Unit

6.3.2 Frame Format

Consistent with the PPDU format shown in Figure 6, the transmitter shall generate a bit stream on the medium in accordance with Figure 7. 'T' is the bit period, equal to 1/(Bit Rate).



Key
a Data
b BitSync
c ByteSync
d Data + 16 bit CRC
e Line-Code Violation
f Beta 1
g Beta 2
h Preamble

Figure 7 — Frame Format for Compliant Transmitter.

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The transmitter shall employ Differential Manchester encoding of data and clock information. This scheme provides a transition (referred to as “clock transition”) at the beginning of every bit period for the purpose of synchronising the receiver clock. Zero/one data are indicated by the presence or absence of a second transition (the “data transition”) halfway between clock transitions.

Clock transitions occur at the beginning of a bit period, and therefore, the last valid bit in the packet does not have a trailing clock edge. Thus, polarity is arbitrary at the start of transmission.

The transmitter shall transmit a preamble at the beginning of a packet to allow the other nodes to synchronise their receiver clocks. The preamble consists of (i) a bit-sync field and (ii) a byte-sync field. The bit-sync field is a series of Differential Manchester “1”s. The byte-sync field is a single-bit Differential Manchester “0” that marks the end of the preamble and the beginning of the first byte of the LPDU/MPDU delivered to the physical layer by the data link layer/media access sub-layer.

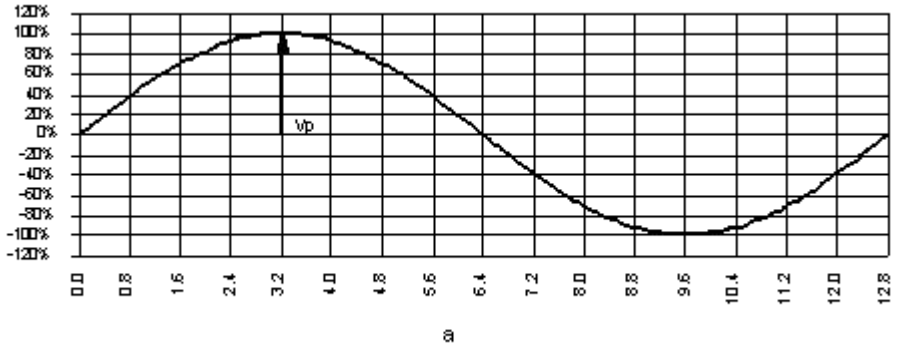
The transmitter shall terminate the packet by forcing a Differential Manchester line code violation, i.e., it shall hold the data output transitionless long enough for the receiver(s) to recognise an invalid bit code. To the receiver(s), this shall signal the end of the packet. Specifically, at the end of packet transmission, the transmitted waveform shall remain transitionless for at least three (3) bit periods after the final clock transition (excepting the final data transition, if present).

The idle periods between packets include the Beta1 and Beta2 slots. For definitions of Beta1 and Beta2, see the prEN 14908-1. The MAC sub-layer generates the timing of these periods. Timing values for the channel type are specified in 7.

6.3.3 Transmit Waveform

The Differential Manchester encoding of the preamble, data and clock shall be in accordance with the waveform shown in Figures 8 and 9. The transmitter peak amplitude (Vp) into 52,3 Ω connected directly at the transceiver output shall be between 0,425 V and 0,900 V over all manufacturing variations and operating conditions.

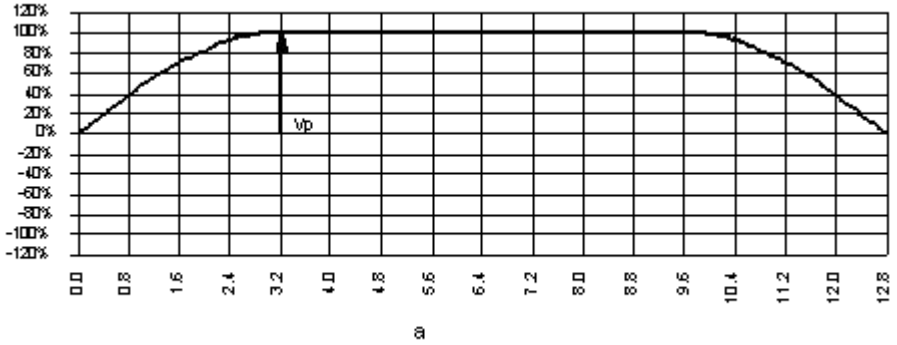
The net voltage remaining on the transmission line after eight (8) bit times from the last clock transition shall be no more than that created by transmitting a pulse of either polarity at peak amplitude for one half of a bit time. The delay from the transmit enable input of the transmitter to the start of transmission on the network shall not exceed 1,125 bit times.



Key
a Time (µsec)

Figure 8 — Idealised Transmit Waveform - Zero Bit

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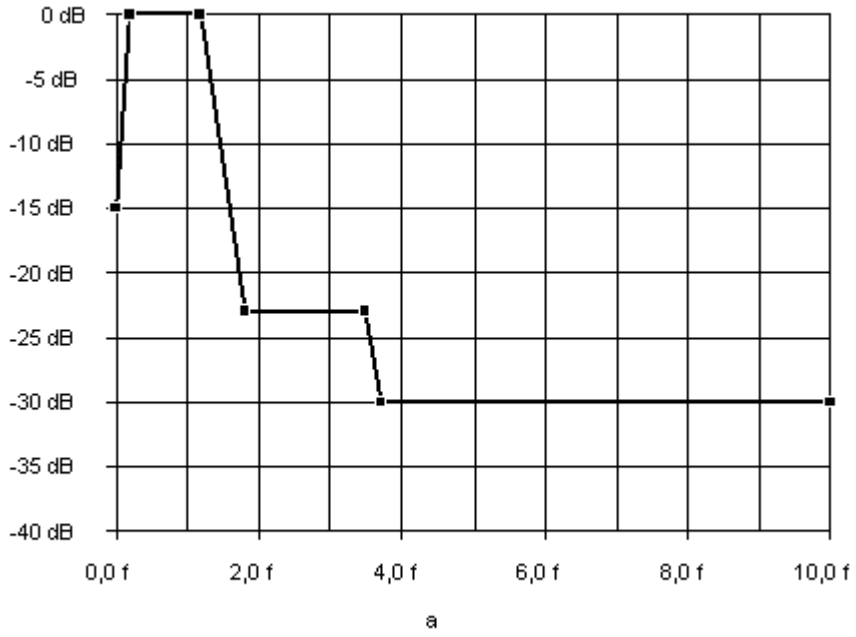
Key
a Time (µsec)

Figure 9 — Idealised Transmit Waveform - One Bit

The voltage spectrum into a network termination of 52,3 Ω connected directly at the transceiver output shall meet the maximum specification of Figure 10 over all manufacturing variations and operating conditions. The random bit pattern to be used for evaluating the voltage spectrum shall be generated by the CRC polynomial

$$G(x) = x^8 + x^6 + x^5 + x^4 + 1.$$

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Key
a Frequency

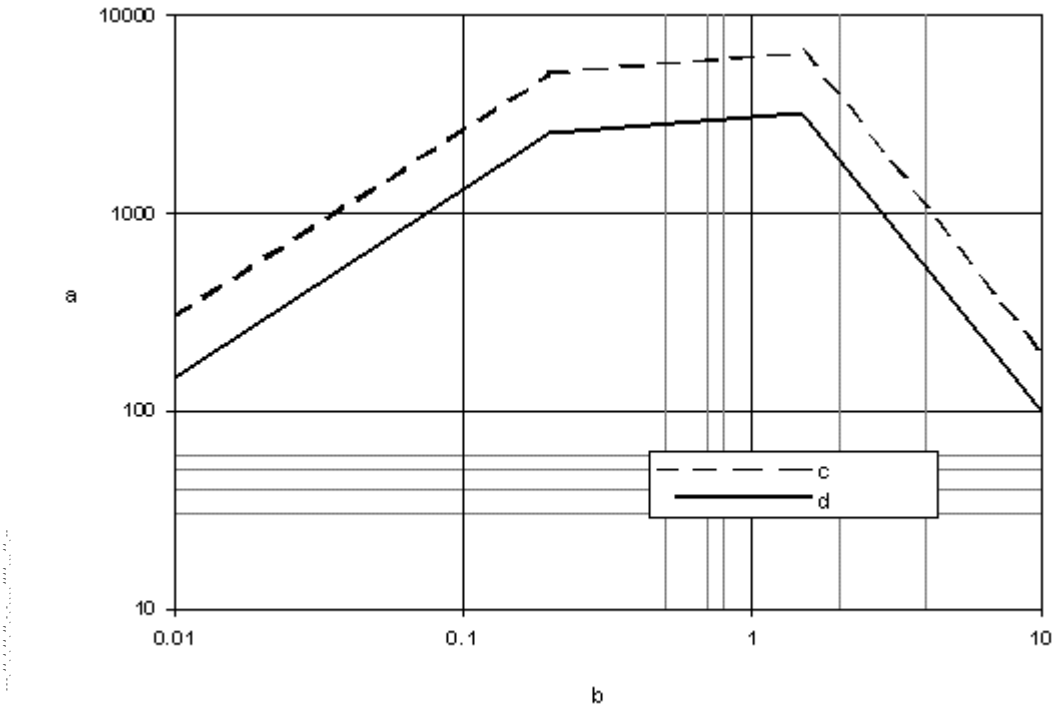
Frequency	Maximum
0,0 f	-15 dB
0,2 f	0 dB
1,2 f	0 dB
1,8 f	-23 dB
3,5 f	-23 dB
3,7 f	-30 dB
10,0 f	-30 dB

Figure 10 — Maximum voltage spectrum over frequency relative to peak

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6.4 Impedance

A node shall meet the minimum impedance specified in Figure 11. In link powered nodes, a notch in the impedance specified by Figure 11 is permitted for use of fixed frequency switching regulators. This notch shall be less than 3 kΩ in depth, less than 0,25 f in width and above 1,6 f, where f = 78 125 kHz. During packet transmission, the transmitter impedance shall be a minimum of 2 000 Ω from 0,2 f to 2 f.



Key
a Minimum Impedence (ohms)
b Frequency
c lonk powered node
d locally powered node

Frequency	Link powered node (Ω)	Locally powered node (Ω)
0,01 f	300	150
0,2 f	5080	2540
1,5 f	6500	3250
10,0 f	200	100

Figure 11 — Minimum Impedance – Powered and Unpowered Node

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7 Communication Parameters

The following communication parameters (Table 6) apply to the free-topology twisted-pair channel. An interoperable transceiver shall meet these specifications. Some of these parameters are controlled by protocol layers other than the physical layer, and thus must be correctly specified as parameters for that layer.

Table 6 — Communication Parameters for Interoperable Transceiver

Communication Rate	78,125 kbps
Number of Priority Slots	4
Minimum No. of Bit Sync Bits	4
Average Packet Cycle	4 020 μs
Preamble Length	301 μs
Beta2 Width	168 μs
Beta1 Transmit Width	868 μs
Beta1 Receive Width	895 μs

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Annex A
(informative)

Environmental Specifications

The environmental specifications for a node, link power supply, and data/power cabling vary with application. Therefore, this European Standard does not specify a standard set of environmental conditions for all devices. The requirements of the appropriate agencies and regulatory bodies should be observed for each application.

Table 7 lists a representative set of environmental specifications for nodes.

Table 7 —Representative environmental specifications for nodes

EMI	FCC Part 15 Class B and EN55022, Class B
ESD Immunity	IEC61000-4-2, Level 2
Radiated Electromagnetic Immunity	IEC61000-4-3, Level 2
Fast Transient/ Burst Immunity	IEC61000-4-4, Level 2
Surge Immunity	IEC61000-4-5, Level 2
Transceiver Operating Temperature	-40 °C to +85 °C

Remark: This Annex A can be deleted if it is covered by the Joint TC205/TC247 working group.

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Bibliography

[1] IEC 61000, Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques, IEC Central Office, 3, rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland; Phone +41 22 919 02 11; Fax +41 22 919 03 00; Internet http://www.iec.ch; Email pubinfor@iec.ch

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