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Home and building electronic systems (HBES) - Technical Report 9: Media and media dependent layers - Network based on twisted pair - Class 1

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REPORT

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English version

Home and Building Electronic Systems (HBES) Technical Report 9: Media and media dependent layers Network based on Twisted Pair, Class 1

This CENELEC Report has been prepared by Technical Committee CENELEC TC 205, Home and Building Electronic Systems (HBES). It was approved by CENELEC on 1995-11-28.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

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Foreword

This Technical Report has been prepared by the Technical Committee CENELEC TC 205 (former TC 105), Home and Building Electronic Systems (HBES). It was decided to ask BT for publication during a voting plenary meeting on September 12 and October 18 and 19, 1995.

It was approved for publication as R205-009 by the CENELEC Technical Board on 1995-11-28.

The final intent of TC 205 is to develop a unique standard, with possible use of different media. The following structure of the series of standards *EN 50090 Home and Building Electronic Systems (HBES)* has been decided:

Part 1: Standardization structure
Part 2: System overview
Part 3: Aspects of application
Part 4: Transport Layer and Network Layer
Part 5: Media and media dependent layers
Part 6: Interfaces
Part 7: Management

Nevertheless, due to historical and market reasons, a first step was taken that allows three different implementations for some parts of the standard, the other parts being common. It is expected that a future version of the HBES standard will only propose one unique implementation, including the existing common parts. For the time being, TC 205 had agreed that the existing different implementations are described in European Prestandards (ENVs).

The three implementations are:

- implementation 1: BatiBUS;
- implementation 2: EIB;
- implementation 3: EHS.

The use of one implementation in a specific ENV requires the use of the same implementation throughout the whole series.

As decided during the meeting of TC 205 held on March 28 and 29th 1995, in accordance with the TC 205 standardization structure as approved by the Technical Board, and in line with TC 205's approach initiated and exposed three years ago as laid down in the CENELEC IT Strategy Plan, the following documents - which were expected to become parts of the EN(V) 50090 series and which describe the protocols of the three proposed HBES implementations BatiBUS, EIB and EHS - had been submitted to vote at plenary meetings of TC 205, in accordance with subclause 7.2 of the CEN/CENELEC Internal Regulations Part 2:

prENV 50090-3-3	Aspects of application - Application Layer
prENV 50090-4	Transport Layer and Network Layer
prENV 50090-5-2	Media and media dependent layers - Network based on Twisted Pair, Class 1
prENV 50090-6-3	Interfaces - Media interfaces
prENV 50090-7	Management

The comments expressed by some National Committees during these meetings reflected the reluctance to the principle of endorsing three existing systems as a step to coming to a unique solution.

Despite the public commitment of the consortia supporting these systems to converge on a unique system, a commitment proven already by the acceptance of:

EN 50090-2-1	System overview - Architecture
EN 50090-2-2	System overview - General Technical requirements
EN 50090-3-1	Aspects of application - Introduction to the application structure
EN 50090-3-2	Aspects of application - User process
R205-001	Applications and requirements - Class 1
R205-002	Guidelines for the professional installation of Twisted Pair cables Class 1
R205-004	Applications and requirements - Class 2 and 3

as well as by the ongoing work in TC 205, none of the arguments put forward could change the opinion of these National Committee delegations.

A formal vote at the meetings showed that there was not sufficient consensus to have the prENVs approved. Therefore the Technical Board decided to publish these documents as CENELEC Reports:

R205-007	Aspects of application - Application Layer
R205-008	Transport Layer and Network Layer, Class 1
R205-009	Media and media dependent layers - Network based on Twisted Pair, Class 1
R205-010	Interfaces - Medium Interface, Twisted Pair, Class 1
R205-011	Management

This Technical Report contains clauses which may be subject to Intellectual Property Rights (IPR)[1].

In accordance with CEN/CENELEC Memorandum 8, the Central Secretariat received a declaration from the three consortia whose protocols are described in this Technical Report, i.e. BCi, EHSA and EIBA, the details of which have been made available to the CENELEC membership.

For full details or IPR conditions the three consortia can be contacted at the following addresses:

BatiBus club international (BCi)
11, rue Hamelin
F-75783 PARIS CEDEX 16

European Home System Association (EHSA)
Excelsiorlaan 11 - Bus 1
B-1930 ZAVENTEM

European Installation Bus Association (EIBA)
Avenue de la Tanche 5
B-1160 BRUSSELS

[1] As defined in CEN/CENELEC Memorandum No 8.

Contents

1 Scope

This Technical Report specifies the mandatory and optional requirements for the Physical Layer, including power feeding, and Data Link Layer for twisted pair class 1 of the Home and Building Electronic System.

2 Normative references

This Technical Report incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this Technical Report only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 29002	Quality systems - Model for quality assurance in production and installation (ISO 9002:1987)
EN 50022	Low voltage switchgear and controlgear for industrial use; Mounting rails - Top hat rails 35 mm wide for snap-on mounting of equipment
EN 60742	Isolating transformers and safety isolating transformers - Requirements (IEC 742:1983, modified)
EN 60950	Safety of information technology equipment, including electrical business equipment (IEC 950:1991, modified)
HD 195	Safety requirements for mains operated electronic and related apparatus for household and similar general use (IEC 65:1985, modified)
HD 21.1	Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V - Part 1: General requirements (IEC 227-1:1979)
HD 21.2	Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V - Part 2: Test methods (IEC 227-2:1979, modified)
HD 366	Classification of electrical and electronic equipment with regard to protection against electric shock (IEC 536:1976)
series HD 384	Electrical installations of buildings
IEC 60-2	High-voltage test techniques - Part 2: Test procedures
IEC 189-2	Low-frequency cables and wires with p.v.c. insulation and p.v.c. sheath - Part 2: Cables in pairs, triples, quads and quintuples for inside installations

3 Definitions

For the purposes of this Technical Report the following definitions apply. They are arranged according to the different implementations.

3.1 Additional definitions for implementation 1

3.1.1 acknowledgement delay: Maximum time the source will wait for acknowledgement of a message containing an ACK request.

3.1.2 acknowledgement request (Ack): 1 bit in the LLC sublayer header. If this bit is set to "1" the receiver shall acknowledge the frame.

3.1.3 address: Information used to reach a specific station.

3.1.4 bit: Binary digit = unit of information (value 0 or 1).

3.1.5 broadcast: An addressing mode in which a frame is sent to all possible destinations; the MAC and LLC sublayers each implement a broadcast addressing mode.

3.1.6 character: An 11-bit string comprising a data byte preceded by a start bit, and followed by a parity bit and a stop bit.

3.1.7 checksum: Redundant information used to check the correct transmission of a frame.

3.1.8 collision: Simultaneous transmission of two or more frames by different points.

3.1.9 extension code (Ext): Part of the LLC sublayer header.

3.1.10 frame: Basic element handled by the data link layer. Two types of frames are distinguished: **data frames** carry application data; **service frames** do not carry any application data, and are used only by the protocol. For the purposes of this Standard, the only service frame is the LLC sublayer acknowledgement (ACK) frame.

3.1.11 intercharacter time: Maximum time interval between two characters within the same frame.

3.1.12 interframe time: Time interval between the end of transmission of the final character of a frame and the beginning of reception of the first character of the following frame.

3.1.12 Logical Link Control: The upper sublayer of the Data Link layer.

3.1.13 Medium Access Control: The lower sublayer of the Data Link layer.

3.1.14 message type (Msg): Part of the LLC sublayer header.

3.1.15 multidrop: An addressing mode in which a frame is sent to a group of destinations; the MAC and LLC sublayers each implement a multidrop addressing mode.

3.1.16 physical: Physical medium over which data exchange occurs.

3.1.17 point: See station.

3.1.18 point-to-point: An addressing mode in which a frame is sent to a unique destination; the MAC and LLC sublayers each implement a point-to-point addressing mode.

3.1.19 retry: Retransmission of a frame

3.1.20 source: Station initiating a frame transmission.

3.1.21 station: Any device connected to the network.

3.1.22 station type (destination [Dest] or source [Emet]): Part of the LLC sublayer header.

NOTE: A **closed circuit** is a pinched circuit, and an **open circuit** is a relaxed circuit.

3.1.2 priority (abbreviation: PRI): Parameter indicating whether the frame has to be sent more or less quicker when line is free.

3.2 Additional definitions for implementation 2

3.2.1 check byte: This byte is used to verify the data transmission reliability.

3.2.2 electrical segment: An electrical segment consists of one or more wiring sections with direct electrical connections between corresponding wires. An electrical segment is powered by at least one bus power supply.

3.2.3 Logical Link Control: Upper sublayer of the Data Link Layer.

3.2.4 Medium Access Control: Lower sublayer of the Data Link Layer.

3.2.5 service data unit: A block of data assembled or dis-assembled by a higher layer of protocol, which is effectively indivisible in this layer.

3.2.6 source: Station initiating a message transmission

3.2.7 telegram: Sequence of characters

3.2.8 wiring section: A wiring section is a linear, uninterrupted, mechanically and electrically defined type of wiring. It is permanently installed as part of a building. It consists of one or more pairs of wires.

3.3 Additional definitions for implementation 3

3.3.1 Alternate Mark Inversion (AMI): A line code which consists of alternate pulses for logic "1" and no pulse for logic "0". TP1 uses this code but with inverted logic levels.

3.3.2 bus: A transmission cable which connects terminals together in a "daisy-chain".

3.3.3 characteristic impedance: The natural propagation impedance of a cable. Terminations are normally chosen to match this value.

3.3.4 client: A layer's client is the entity which uses the services provided by the layer. This entity is usually either the next higher layer in the protocol stack, or the station management entity. For example, the LLC has two clients: it offers data transfer services to the Network Layer, and layer management services to the station management entity.

3.3.5 Common Mode Rejection Ratio (CMRR): The ability of a circuit to reject non-differential signals at its input.

3.3.6 even parity: A bit added to a word in order to make the total number of marks even.

3.3.7 galvanic insulation (barrier): Hardware für connecting together bus circuits where a large potential difference exists between them.

3.3.8 Insulation Displacement Connector (IDC): A means of connecting to a cable without the use of screw terminals or soldering.

3.3.9 Layer Management Services: Services, usually used by a client station management entity, which do not directly result in communication between station, but change or interrogate the internal state of the layer (e.g. to set or read addresses stored in a layer)

3.3.10 main bus: See "Bus".

3.3.11 Protocol Data Unit (PDU): A block of data assembled by this layer, and used to communicate with the peer layer in another unit.

3.3.12 Service Data Unit (SDU): A block of data, assembled or dis-assembled by a higher layer of the protocol, which is effectively indivisible in this layer.

3.3.13 stub: A short length of cable used to attach an appliance directly to a bus.

3.3.14 Switched Mode Power Supply (SMPS): A dc to dc regulator which uses high frequency switching. It can usually provide galvanic insulation.

3.3.15 termination: A load resistor designed to match a bus or stub at a defined impedance.

3.3.16 Uninterruptible Power Supply (UPS): A type of backup power supply which becomes active immediately, or almost immediately, after failure of the primary supply.

4 Abbreviations

LLC Logical Link Control
MAC Medium Access Control

4.1 Additional abbreviations for implementation 1

ACK Acknowledgement frame.
CKS Checksum
h indicates that the value is in hexadecimal notation.
LPDU LLC sublayer Link Protocol Data Unit
LSAP LLC sublayer Link Service Access Point
PDU Protocol Data Unit
QOS Quality Of Service

4.2 Additional abbreviations for implementation 2

PDU Protocol Data Unit
SDU service data unit

4.3 Additional abbreviations for implementation 3

AMI: Alternate Mark Inversion
CMRR: Common Mode Rejection Rate
DIY: Do It Yourself
IDC: Insulation Displacement
SMPS: Switched Mode Power Supply
UPS: Uniterruptible Power Supply

5 Physical Layer Class 1

This clause specifies the Physical Layer for the three implementations.

5.1 Implementation 1

5.1.1 Topology

5.1.1.1 Network topology

Any topology complying with the requirements specified below shall be authorized; acceptable variants include bus, ring or star topologies alone or in combination. The network topology must take line polarity into account.

5.1.1.2 Possible network configuration examples

Figure 1 to figure 5 show different possible network configuration examples.

Key to figures :

S : station
v : station connection
> : station connection
* : the power supply may be included in a station

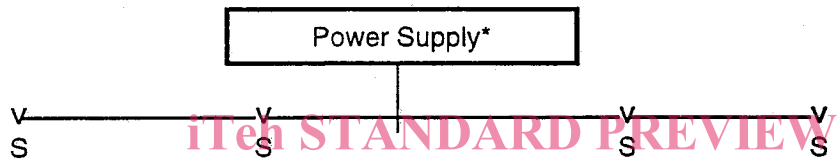

Figure 1: Serial Bus Topology

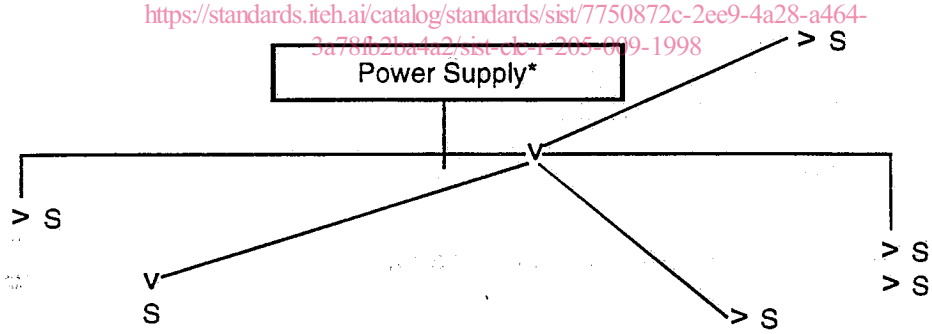

Figure 2: Star Topology

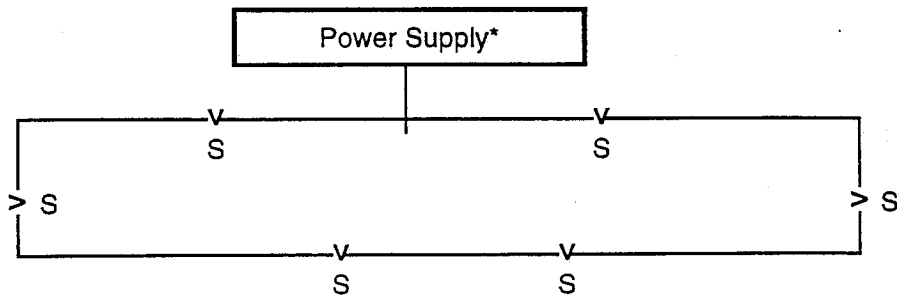

Figure 3: Loop topology

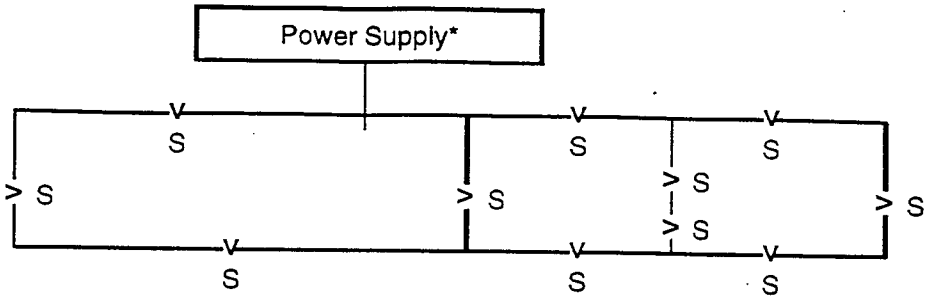

Figure 4: Mesh topology

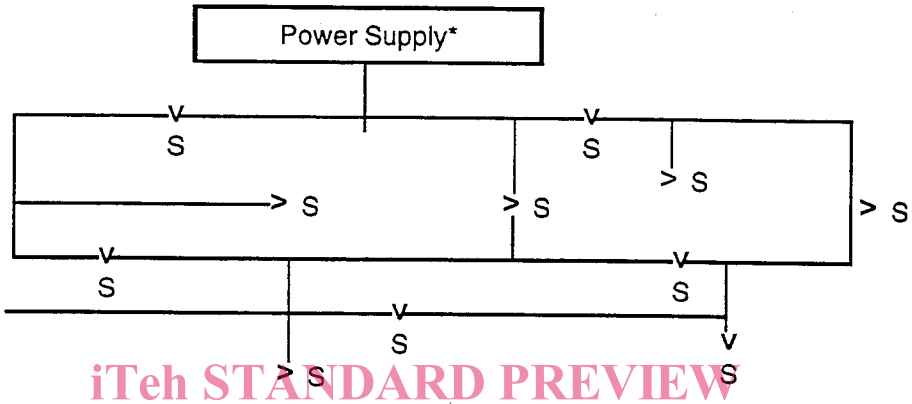

Figure 5 : Mixed topology

5.1.2 Connectors and coupling

5.1.2.1 Cable

The cable is a twisted pair, either shielded or unshielded. No special termination is required. The cable provides for data transmission to all stations, and power supply to bus-supplied stations.

The network shall comply with the following requirements :

a) Connections shall be made via a shielded or unshielded twisted pair with two colour-coded conductors. Line polarity shall be observed at each station. No termination is required at the cable ends.

b) The total length of the medium shall be determined by signal attenuation, in compliance with the requirements specified in 5.1.1.

Physical interconnection components shall comply with the following equipment and personnel safety-related standards: HD 366, EN 60742, HD 384, HD 195 and EN 60950.

5.1.2.2 Connectors

Plug-in connection

Connector with 2" pitch is to be used. The male plug is on the device. Figure 6 shows a view from the bus of a station connector :

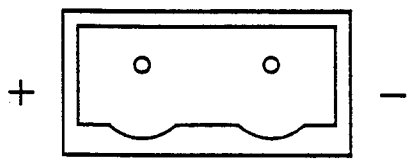

Figure 6 : View of a station connector

Fixed connection

No special requirements.

5.1.3 Power feeding service

The modulation technique used allows connection to the bus of stations supplied with power from the bus, and stations supplied by an external source (e.g. 230 V mains). The available bus-supply current is 150 mA, sufficient to supply 75 stations with 2 mA supply current. Bus-supplied stations shall ensure retention of required data during a 200 ms line open-circuit condition.

Bus-supplied station current consumption

To simplify system engineering, the supply current of a station is expressed by a factor "C", defined as the ratio of the current drain of the station in question to the current drain of a reference station. C shall be calculated for the average and peak current drain, and the higher of the two values shall be rounded up to the next higher integer value. The sum of all the C values for an installation shall not exceed 300.

- Reference station supply current : average (quiescent): 0,5 mA max.
  peak (reception): 0,825 mA max.

- Line supply current for a station supplied by an external source: average: 100 µA max.

In order to ensure proper power supply of bus-supplied stations, the line shall not be in open-circuit condition more than 25% of the time during any period of 800 ms max. As the time interval between frames is 22 ms, this requirement is met without flow control for frames with less than 2 data bytes.

The bus installations is a Safety Extra Low Voltage (SELV) or a Protective Extra Low Voltage (PELV) system as according to EN 60742. The bus power supply specifications required to guarantee rated performance are the following:

- Voltage without load: nominal value 15,5 V, tolerance ± 10 %.
- Voltage with load : > 13,8 V @ 150 mA.
  > 13,5 V @ 250 mA.

- Circuit current: nominal value 300 mA, tolerance ± 10%.

- Power on/off switching shall be provided (the maximum current provided by the station when it is switched OFF will be less than 1 mA).

- Power supply shall withstand a permanent line short-circuit condition.

- Sum of bus-supplied station capacitance value: 40 nF (corresponding to a power-on time of 3 s max.).

5.1.4 Functional specification

5.1.4.1 Signalling

Modulation rate : 4800 bauds

5.1.4.1.1 Coding

The network uses line open/closed-circuit modulation. The physical layer sends or receives data in packets comprising a start bit, 8 data bits, an odd parity bit and a stop bit. Figure 7 shows the format of this packet.

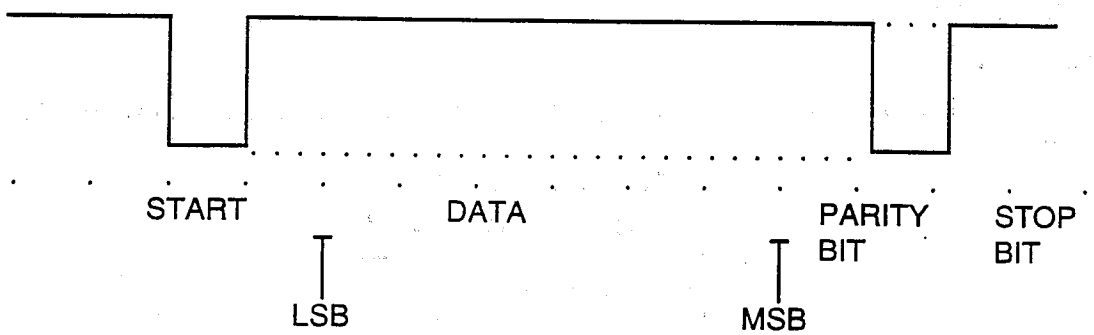

Figure 7: Format of the physical layer packet

Required electrical characteristics are the following :

Receiver:	Start:	U < 7V.
	Stop:	U > 9V
	Logic "0":	U > 9V Open
	Logic "1":	U < 7V Closed
Sender:	Start:	U < 1,5V @ 330 mA.
	Stop:	I < 100 µA @ 18 V
	Logic "0":	I < 100 µA @ 18 V (open circuit)
	Logic "1":	U < 1,5V @ 330 mA (closed circuit)

NRZ (non-return to zero) code is implemented. Figure 8 shows an example of transmission.

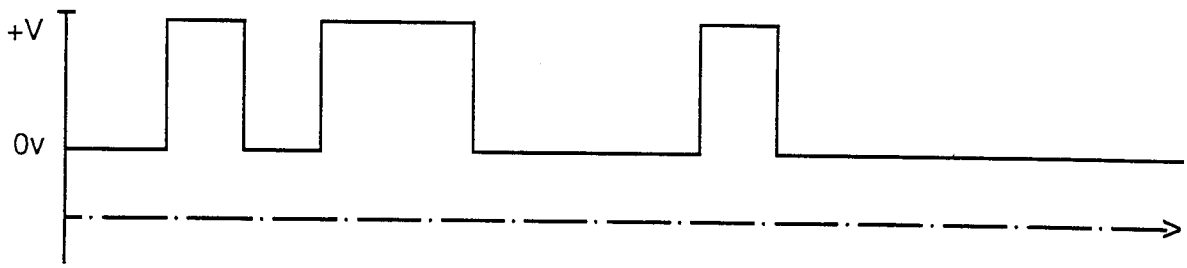

Figure 8 : Example of NRZ transmission

Fault orientation: circuits shall be designed so the most likely failure mode of any component will not close the line.

5.1.4.1.2 Medium Access

Collision detection and arbitration is the main problem. A collision occurs when two or more stations transmit simultaneously after detecting a free line condition (open circuit).

A station may detect a collision by a discrepancy between its transmission and reception.

A station shall consider that a collision has occurred if the line switches to closed condition between the moment it detects a free line and the moment it transmits.

A sender that transmits a Logic "0" and receives a Logic "1" shall terminate the transmission of its rame after the first bit in collision.

During open/closed and closed/open transitions, the system time constants cause an apparent fault condition that shall not be considered as a collision.

In order to prevent loss of frames in the event of a collision, all stations shall store any data received while they are transmitting.

- Time to free line in case of collision : ≤ 180 µs
- Filtration time of the collision detection during open/closed transition : > 20 µs.

Free Line Detection: The line shall be considered free if no line closed-circuit condition occurs during at least 2,288 consecutive ms. The time required for this test may be included in the interframe time.

5.1.4.1.3 Electrical specifications

5.1.4.1.3.1 Sending station

A sending station has following characteristics :

- Maximum closed-circuit voltage across terminals : 1,5V @ 330 mA.
- Maximum open-circuit leakage current : 100 mA Max. @ 18 V.
- Maximum distortion : 10%

5.1.4.1.3.2 Receiving station

A receiving station has following characteristics :

- Maximum input resistance: 500 kΩ
- Minimum supply current per station: 30 mA
- Threshold voltage : (8 ± 1) V
- Minimum permissible distortion: 30 %

5.1.4.1.3.3 Transmission lines

The transmission line has following characteristics :

- Maximum line resistance: 12 Ω between power supply and most remote station.
- Maximum line voltage drop: 3,6 V.
- Maximum line capacitance: 250 nF.
- Maximum station capacitance: 50 pF.
- Maximum total station protection capacitance : 150 nF.
- Make/break and break/make switching time (unloaded line): > 0,75 µs ;< 5 µs

5.1.4.1.3.4 Bus technology

The bus technology has following characteristics:

a) Maximum coupling capacitance:

Input/line : 5 pF per station connected to bus.
Output/line : 5 pF per station connected to bus.
Line/230V mains : 50 pF.

Line/earth and mains/earth insulation : in compliance with applicable standards.

The following specification values are cited for reference only ; safety requirements shall comply with EN 60742 :

. Dielectric strength: Line/230 V mains: 4 kV for 1 min @ 50 Hz.

. Line/metal masses connected to protection conductor: 2 kV for 1 min @ 50 Hz.

. Insulation resistance: Line/230 V mains: 5 MΩ @ 500 V.

. Minimum creepage distance: Line/230 V mains : 8 mm.

. Line/metal masses connected to protection conductor: 3 mm.

b) Impulse voltage performance according to IEC 60-2:

Common mode: 4 kV, series resistances < 50 Ω, energy 2J.
Differential mode: 2 kV, series resistance < 50 Ω, energy 0,5J.

The tests results shall be considered satisfactorily if the device specifications are maintained after having received 3 positive pulses and 3 negative pulses in both common and differential mode.

5.1.4.2 Protocol

The physical layer provides connectionless service. For the purposes of the following discussion, the term "user" shall designate the MAC sublayer.

5.1.4.2.1 Operation

The user invokes the transmission service by means of the PHY_EMISSION primitive.

After sending this primitive, the user cannot invoke the service again until a response is received.

The user receives one of the following primitives on completion of the transmission :

PHY_FIN_EMISSION
PHY_ERR_EMISSION
PHY_COL_EMISSION

The physical layer sends the user one of the following primitives when activated by the line :

PHY_RECEPTION
PHY_ERR_RECEPTION

(These services are described in clause 5.1.4.3 Services)

5.1.4.2.2 Parameters

There are no parameters specific to the physical layer.

5.1.4.2.3 Physical Layer variables

State = (QUIESCENT, REC_EN_COURS, EMI_EN_COURS)

ERREUR_EM : boolean value indicating whether an error occurred during transmission of the current frame.

5.1.4.2.4 Predicate finite state machine

Initialization

state := QUIESCENT

ERREUR_EM := false

Predicates

p1 : (11-bit character sent) ?

p2 : (ERREUR_EM = true) ?

p3 : (received character OK) ?

p4 : (bit read on line = bit to be sent) ?

Actions

(1) : assemble 11-bit character for transmission

(2) : begin or continue transmission

(3) : interrupt management and transmission of pending bits ;
bits already sent are kept as beginning of reception

(4) : begin or continue reception

(5) : check 11-bit incoming character

(6) : ERREUR_EM := true

(7) : ERREUR_EM := false

States

QUIESCENT : neither transmission nor reception in progress

EMI_EN_COURS : transmission in progress

REC_EN_COURS : reception in progress

Table 1 gives the status chart of the predicate finite state machine.