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Mains communication systems - Protocol and data integrity and interfaces

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CENELEC

R205-006

REPORT

October 1996

English version

Mains communication systems
Protocol and data integrity and interfaces

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

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CENELEC
European Committee for Electrotechnical Standardization
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Europäisches Komitee für Elektrotechnische Normung

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INTRODUCTION

This CENELEC Technical Report was originally drafted to form part of EN 50065 to give physical layer and MAC layer specifications for mains signalling equipment operating in the band 125 kHz to 140 kHz and using the low-voltage electrical network for signalling in consumer's premises. It has been found to be unsuitable as a standard because the protocols described do not accord with the upper layer requirements under development by TC 205 - Home and Building Electronic Systems. However, CENELEC SC 205A considers that the information should be published to make it available to other workers in the field.

This report describes specifications for protocols for Mains Communication Equipment Systems (MCES), sometimes known as power line carrier systems (PLC). It gives guidance to implementation using « X-3000 » and « EHS » as examples. Further examples added in due course.

OSI layers 1 and 2a are described in accordance with ISO 7498 (EN 27498)

Descriptions of the relevant physical layers and MAC layers are given under clauses 5 to 8 of the report.

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1 Scope

This CENELEC report describes the requirements for the Physical and MAC layers of two current MCES implementations. Other examples may be added in due course.

2 Definitions

The terms in this report are defined by the International Electrotechnical Vocabulary IEC 50.

Other terms not covered by the IEC will be defined in EN 50065.

3 Medium characteristics

3.1 Topology

The physical topology of the transmission medium is that of the existing power distribution network, for example, star, bus, ring or any combination. Mains Communication Equipment/Systems (MCES) are assumed to operate in any topology.

3.2 Medium Aspects

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3.2.1 Coupling Characteristics

Several coupling modes are possible : series and parallel injection or any other method permitted by the safety rules applying to the different media, especially when bridges, routers, phase couplers or gateways are used.

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Regulations often prohibit the use of the protective conductor for signalling.

Coupling devices shall not disturb the operation of electrical safety/protective devices, for instance, residual current circuit breakers.

3.2.2 Impedance

The values of the impedance at each connection point may vary considerably, lying within a range of less than 1 ohm to more than 50 ohm according to the types of connected load.

Additional components may need to be connected to increase the impedance presented to the system or reduce the noise emission of connected loads. The impedance of the MCES itself shall conform to the standard currently in preparation by CENELEC SC 205A.

3.2.3 Filters

If filters are used they shall conform to the standard currently in preparation by CENELEC sub-committee SC 205A.

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4 Basic transmission characteristics

The transmission requirements shall comply with EN 50065-1 standard and are characterised as follows :

BASIC TRANSMISSION CHARACTERISTICS TABLE		
Parameters	**X 3000**	**EHS**
Frequency	132,5 kHz +/-0,5%	Central 132,5kHz +/- 0,2%
Modulation type	ASK ON-OFF keying	MSK deviation: +/-600Hz
Data 0	Carrier ON	Highest frequency
Data 1	Carrier OFF	Lowest frequency
Synchronisation to the main coding	None	None
	NRZ	NRZ
Synchronisation Data	by bytes on start bit (Asynchronous)	on each bit (Synchronous) and on Header field
Access protocol	CSMA/CD Compliant EN 50065 part 1	CSMA Compliant EN 50065 part 1
Data rate	600	2400 bps
Data format format	1 Start bit, 8 data bits 1 Odd parity, 1 Stop bit	Data: 8 bits 6 Redundancy bits
Packet Type	-a variable length telegram format -a telegram acknowledge format	-a variable length datagram - a datagram acknowledge - two escape datagram
Preamble	00h	AAAAh
House Address	16 bit random with check	16 bit random
Destination Address	Individual Addressing Group Addressing	8 bits Individual or Group Addressing, 4 bits address extension
Source Address	16 bit Addressing Individual number	16 bit Addressing, 4 bits address extension

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5 X 3000 Physical layer specifications

5.1 Signalling

The **PHYSICAL** layer has three functions:
- emission of streams of serialised bits
- reception of streams of serialised bits
- observation of the channel

* The emission of bits occurs when the **MAC** layer transmits a primitive **PHY_DAT.Request** supporting the octet to be transmitted. This octet is transmitted bit by bit, least significant bit first.

* The reception of bits is restored in Octets, this octet is transmitted to the **MAC** layer by the primitive **PHY_DAT.Indic.**, the parity is controlled by the Physical layer. The Physical layer takes charge of the encapsulation or decapsulation of the start and stop bits.

* Observation of the channel is carried out by the positioning of different parameters transmitted to the **MAC** layer by the primitive **PHY_STAT.Indic.**.

5.1.1 Carrier

Power-line signalling equipment will interface to local power line systems with the following characteristics :

A.C. single phase
50 Hz-10% to 60 Hz+10%

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The signal connection will be made between the live and neutral wires. It is possible to use it on triple phase systems with the use of couplers.

5.1.2 Frequency

The frequency is 132,5 kHz *(± 0,5 %)*.

5.1.3 Modulation type

The modulation type is Amplitude Shift Keying *(ASK)*, modulation all or nothing, also called ON-OFF Keying *(OOK)*.

5.1.4 Coding

The coding type is Non-Return-To-Zero *(NRZ)*.

5.1.5 Data Transmission mode

Transmission is asynchronous. Synchronisation is done by start bit.

5.1.6 Data rate (bit timing)

The data rate is 600 bit/s.
The bit timing is 1,66ms (± 0,5%)
- "Data 0" *(Low)* is a period carrier ON
- " Data 1" *(High)* is a period carrier OFF

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5.2 Data format

5.2.1 General synoptic

The general synoptic of a station is represented below (figure 1):

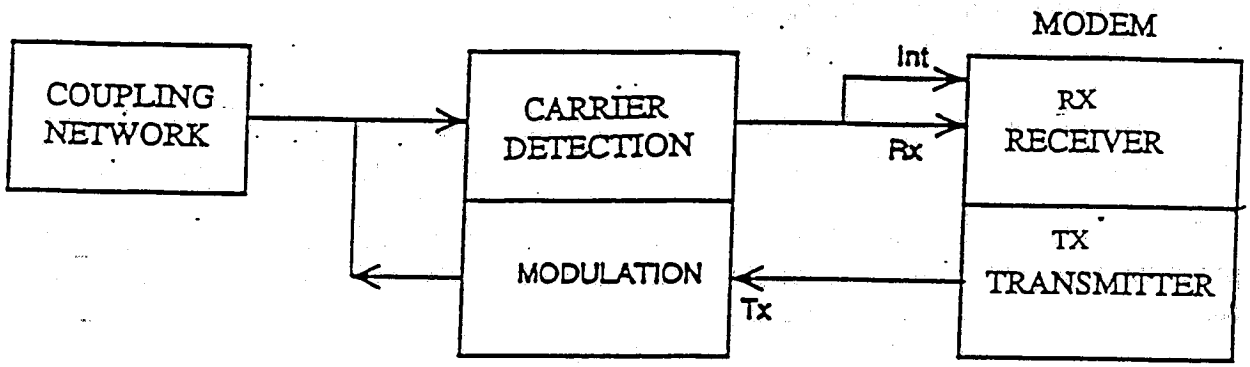

Figure 1 : Synoptic

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5.2.2 Physical layer format

The physical layer sends or receives data in packets comprising a start bit, 8 data bits, an odd parity bit and a stop bit.

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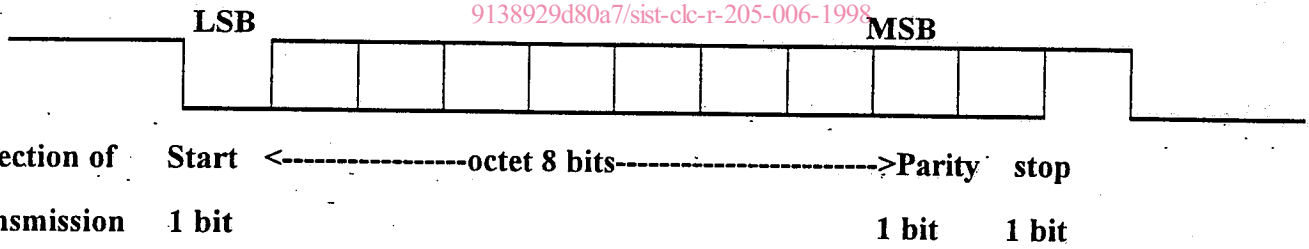

Start =Low =carrier presence

Stop = High =carrier absence

Figure 2 : Format of the physical layer packet

5.2.3 Preamble

The datagram preamble is an 8 bit field : 00H.

The purpose of the preamble is to train the demodulator and to allow datagram synchronisation.

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5.2.4 Packet format

Two packet formats are provided:

- a variable length datagram (figure 3),
- an Acknowledge datagram (figure 4).

1 octet	1 octet	2 octets	2 octets	2 octets	n octets	1 octet
Preamble	Noct I xxI I	House code	destin.add.	Source add.	Data	FCS

Figure 3: Variable length datagram

Preamble	Noct = 2	FCS

Figure 4: Acknowledge datagram

Preamble : 00h
Noct : Number of octets in the grid (excluding preambule, out of 5 bits) I =1:IACK requested
House code : House address, out of 16 bits, random.
Destination Address : Address of individual destination out of 16 bits
Source Address : Individual address of source (16 bits)
Data : Network information, for application and data.
FCS : Cheksum (16 bits).

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5.2.5 Code format

NRZ code is implemented. Figure 5 shows an example of transmission

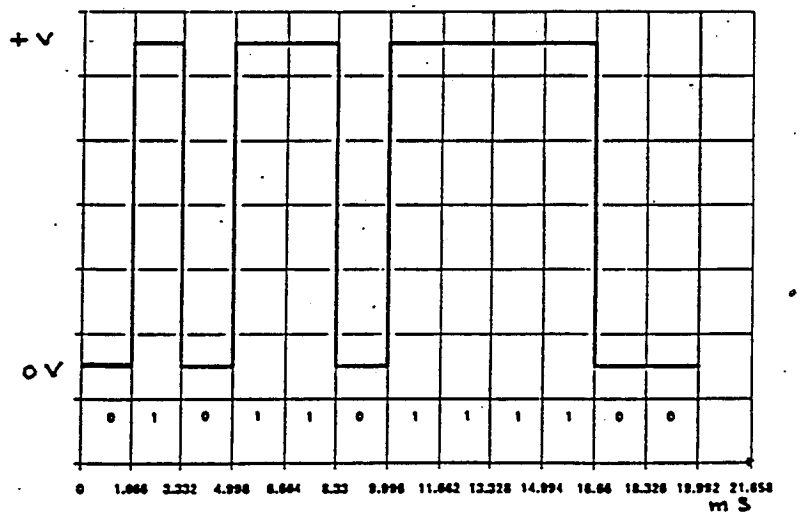

Figure 5 : Example of NRZ transmission

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5.2.6 State of signals

State of signals are visualised on the diagram below (figure 6):

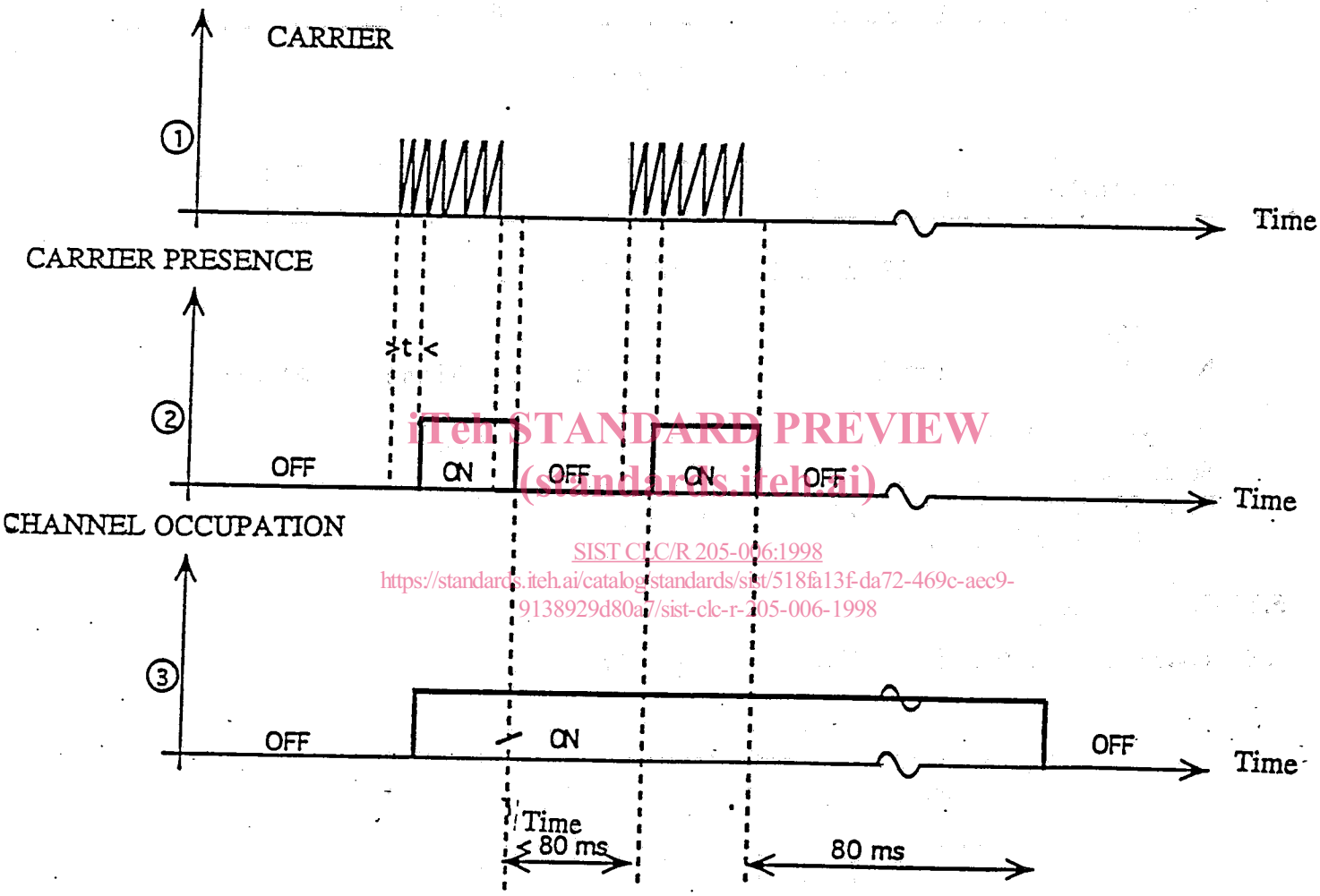

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Figure 6 : State of signals

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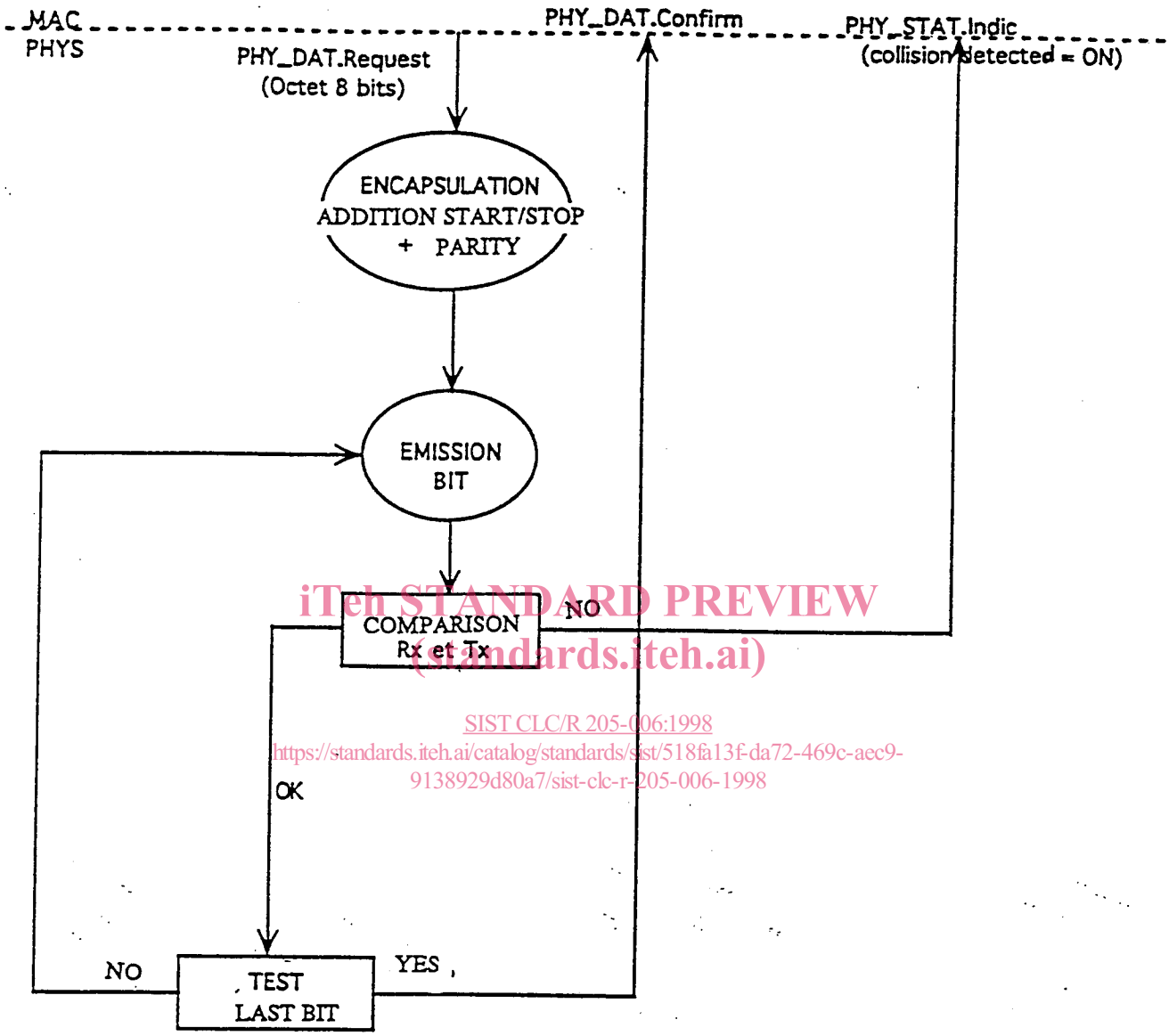
5.3 Layer services

5.3.1 Automatic transmission device



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The **PHYSICAL** layer receives an octet on 8 bits associated with the primitive **PHY_DAT.Request**. It calculates and adds the parity, and encapsulates it with start and stop.
Emission then takes place bit by bit as from the start, on emission of each bit, the system checks that the emission is equivalent to the reception Rx.
A collision happens when 2 or more stations transmit simultaneously after having detected an empty line.
Detection of a collision is ensured in the following way: any transmitting product listens to the line while transmitting a 1(absence of carrier); if during this time, it hears a 0 data, there will be a collision; it stops transmitting and informs the MAC layer via PHY_STAT.Indic. The device transmitting a 0 at the moment of the collision does not detect it and can continue to transmit its message, the other device leaves the field empty.
If the comparison is good, bit by bit emission continues until the 11th bit corresponding to stop. After the 11th bit, a primitive **PHY_DAT.Confirm** is automatically generated towards the **MAC** layer, signalling the end of current transmission of the octet.