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Izmenjava podatkov pri merjenju električne energije - Niz DLMS/COSEM - 4. del: Fizična plast, temelječa na modulaciji SMITP B-PSK in plasti SMITP za povezavo podatkov

Electricity metering data exchange - The DLMS/COSEM suite - Part 4: Physical Layer based on SMITP B-PSK modulation and SMITP Data Link Layer

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Electricity metering data exchange - Part 4: Lower layer PLC profile using SMITP B-PSK modulation

This Technical Specification was approved by CENELEC on 2014-11-11.

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Foreword

This document (CLC/TS 50568-4:2015) has been prepared by CLC/TC 13, "Electrical energy measurement and control".

The following date is fixed:

- latest date by which the existence of this document has to be announced at national level (doa) 2015-07-24

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Introduction

This Technical Specification is based on the results of the European OPEN Meter project, Topic Energy 2008.7.1.1, Project no.: 226369, www.openmeter.com.

According to the structure of the CLC/TS 50568 documentation, this document is positioned as highlighted in the following figure:

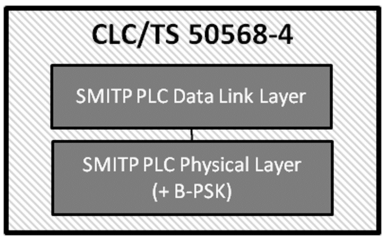

Figure 1 – Document structure of CLC/TS 50568-4

1 Scope

This Technical Specification specifies the characteristics of the profile related to Physical and Data Link Layers for communications on LV distribution network between a Concentrator (master node) and one or more slave nodes.

The following prescriptions are applied to groups of devices that communicate using low voltage network. Each section of the network is composed by one Concentrator (acting as the master of the section), and one or more primary nodes (A-Nodes). Every A-Node can optionally be associated to one secondary node (B-Node).

2 Normative references

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

EN 50065-1, *Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz – Part 1: General requirements, frequency band and electromagnetic disturbances*

3 Terms, definitions, acronyms and notations

3.1 Terms and definitions

For the purpose of this document, the following terms and definitions apply:

3.1.1
concentrator section
identification code of the network managed by the concentrator

3.1.2
node subsection
identification code of the sub network within the network identified by concentrator section

3.1.3
node progressive
unique node ID within the node sub section

3.1.4
upper layers
every communication stack layer except PHY, MAC and LLC

3.2 Acronyms

For the purpose of this document, the following acronyms apply:

ACA: Absolute Communication Address
B-PSK: Binary Phase Shift Keying
CRC: Cyclic Redundancy Check
D-L: Data-Link
ECC: Encryption Coding Control
ECTL: Extended Control
HDLC: High-level data link control procedures
LLC: Logical Link Control
LSb: Least Significant bit
LSB: Least Significant Byte
LSDU: LLC Service Data Unit
LV: Low Voltage

MAC: Medium Access Control
MAU: Mains Attachment Unit
MSb: Most Significant bit
MSB: Most Significant Byte
NDM: Normal disconnect mode, one of the non-operational data link mode of HDLC
NM: Network Management
Ph: Physical
PLS: Physical Signalling
PRE: Preamble
PSK: Phase Shift Keying
SAP: Service Access Point
SCA: Section Communication Address
UL: Upper Layer
UW: Unique Word

3.3 Notations

For the purpose of this document, the following notations apply:

– 1 byte = 8 bits (or octet);

– byte/field name representation: capital letters;

– bit name representation: small letters;

– bits transmission sequence related to their representation: first bit on the left = first transmitted bit;

– bit transmission order related to their weight: least significant bit = first transmitted bit;

– bytes transmission sequence related to their representation: first byte on the left = first transmitted byte;

– bytes transmission order related to their weight: least significant byte = first transmitted byte;

– fields transmission sequence related to their representation: first field on the left = first transmitted field;

– fields transmission order related to their weight: least significant field= first transmitted field;

– a frame/message is “upstream” if it is logically sent from centre to periphery;

– a frame/message is “downstream” if it is logically sent from periphery to centre.

4 Overview

4.1 Communication characterization on LV network

The Physical Layer configuration on LV network is considered as a multi-point connection of nodes operating in half-duplex mode. So, access rules are required in order to avoid nodes transmission collisions.

Furthermore, it has to be considered that LV network cannot be treated as a normal broadcast medium, because standing-waves phenomena and most of all signal attenuation may make direct communication between couple of nodes impossible.

In order to obtain a virtually direct communication, between any couple of nodes, the protocol functionalities shall foresee the repetition technique. Figure 2 shows the reference scheme of a LV line portion, which is identified as communication section. A LV network controlled by a Concentrator is composed by a set of branch-connected sections of this kind:

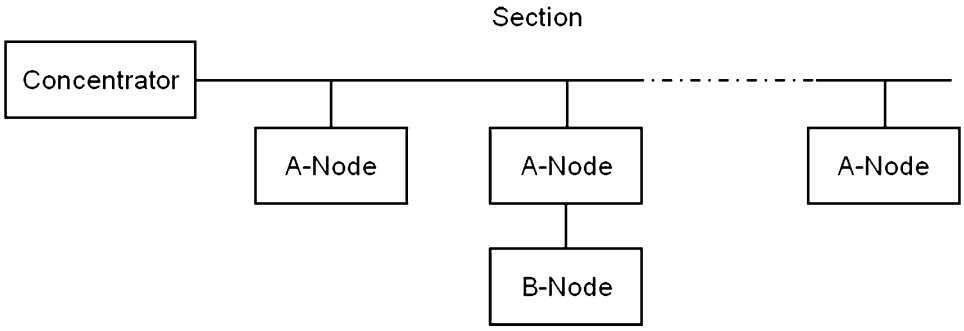

Figure 2 – Communication section in a LV line

where:

– information exchanging is required either between Concentrator and any node, or between an A-Node and the associated B-Node;

– message transferring shall always happen on the A-Node electric connection phase. In case of polyphase meter, communication shall always happen through one of the three phases, the same one for all communications;

– each A-Node and B-Node has its own unique address.

There are the following two types of sub-nets. Each one is unbalanced (the initiation of transmission procedure is limited to a master or a sub-net master station), with one or more slave nodes.

A sub-net

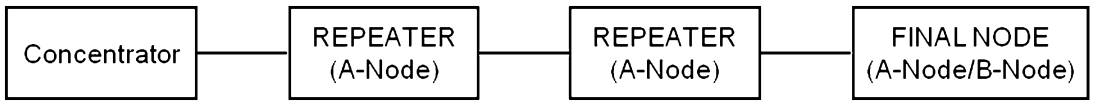

Figure 3 – A sub-net

Within A sub-net, communications between Concentrator (master station for this sub-net) and any node (slave), with single or group addressing, are defined. This sub-net can use repetition.

B sub-net

Figure 4 – B sub-net

Within B sub-net, communications between A-Node (master station for this sub-net) and the associated B-Node (slave) are defined. This sub-net does not foresee repetition.

The profile of protocols to be used has to reach the following objectives:

– to satisfy application requirements in terms of efficiency and effectiveness;

– to reduce data amount to supply to equipment during network configuration stage as much as possible;

– to make efficient use of the channel;

– to support all the group addressing performances, according with what is required by applications, also in presence of a network with repetitions.

4.2 Communication architecture

4.2.1 Overview

This document describes a lower layer profile that includes the Logical Link Control, the Medium Access Control and the Physical Layers.

The repetition functionality is inserted in the MAC sub-layer, in order to guarantee to LLC sub-layer the direct exchange between Concentrator master node and each of the slave nodes.

4.2.2 LLC sub-layer

LLC sub-layer interfaces the Upper Layers on the upper side and the MAC sub-layer on the lower side. It is required to support the following functions:

– it is responsible about the execution of end-to-end exchange procedures to guarantee a correct access procedure that avoids any possible collision on the network (in any moment a single node can ask a transmission request on MAC level); it manages access times to the LV communication on the master node;

– it operates end-to-end between master nodes and all the slave nodes; it offers a connectionless-type service to equipment applications, according with the kind of exchange procedure required;

– in master nodes, it indicates to Upper Layer the network availability; the transmission of another message can be requested, upon reception of this indication;

– in master nodes, it manages re-transmissions (retry) on exchanges with expected answer.

The mechanisms to provide the above listed features are left to the implementers of the Master node without any limitation on interoperability.

LLC sub-layer does not check the correctness of the used disciplines (see 4.4); it's up to the upper layer to select it properly.

4.2.3 MAC sub-layer

In this sub-layer, the repetition functionalities (MACre) are distinguished from the physical interfacing functionalities (MACph).

MACre functions:

– it operates end-to-end between master node and all the network slave nodes offering a connectionless service;

– it uses the services supplied by MACph to transfer frames with the limited goal to provide necessary functions for the packet transfer between a master node and a slave final node on a multi-point Data-Link with hidden stations (slave nodes that need one or more repeaters to communicate with the master node);

– it manages the timers of busy network condition in master nodes and repeaters.

MACph functions:

– frames encapsulation;

– received frames filtering, on the basis of a single or grouped address;

– frame errors detection.

The access mode to the physical medium is half duplex. MACph is capable to distinguish correct frames from not correct ones, but it does not handle error recovery. A wrong frame is rejected.

MACph also handles connection electric phase detection of LV: the correlation between frame and LV phase shall happen:

– in transmitting mode on Concentrator and on A-Node repeater;

– in receiving mode on all the A-Nodes;

while the correlation shall happen in both mode types on B-Nodes.

NOTE The phase detection algorithm depends on the specific implementation adopted by manufacturers.

4.2.4 Physical Layer

4.2.4.1 Introduction

The Physical Layer (PHY) defines the method used to transfer data over the physical medium (power line), by performing:

– encapsulation of data in a physical frame;

– modulation / demodulation of the physical frame using B-PSK scheme.

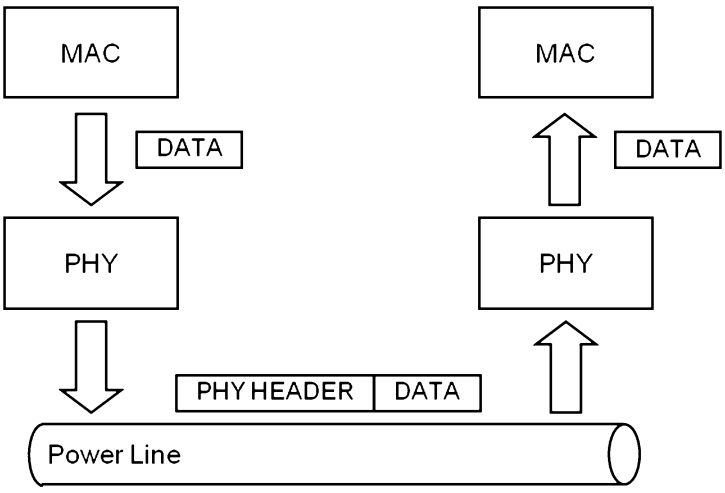

Figure 5 – Data transfer on power line

Additionally, the Physical Layer provides following services:

– bit and byte synchronization;

– Signal to noise ratio (SNR) estimation. When implemented, this functionality may be used for Network Management purposes (out of the scope of this document).

4.2.4.2 Modulation and modes

The modulation is a B-PSK (Binary Phase Shift Keying) with a symbol rate equal to 9600 symbol/s. To improve the robustness of the communication in noisy environments, an error correction technique is implemented through the use of a convolutional code with rate ½ and an interleaver. Therefore, the resulting bit-rate is 4800 bps.

4.2.5 Protocol's architecture for LV nodes communication

Referring to LV sub-nets, the following figures show the protocol stack in each equipment:

in A sub-net:

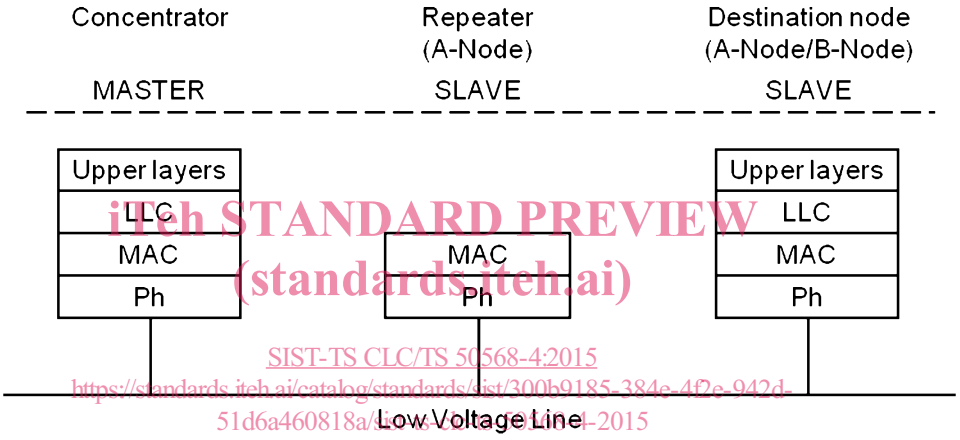

Figure 6 – Protocol's architecture in the A sub-net

in B sub-net:

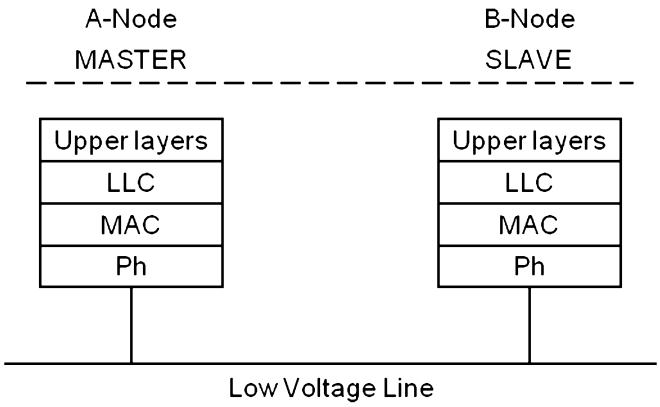

Figure 7 – Protocol's architecture in the B sub-net

Each node type shall own a protocol profile including all the sub-layers required by the sub-nets in which the node works.

Sub-layers required to Concentrator: