IEC 62056-3-1

Edition 2.0 2021-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Electricity metering data exchange – The DLMS/COSEM suite – Part 3-1: Use of local area networks on twisted pair with carrier signalling

Échange des données de comptage de l'électricité – La suite DLMS/COSEM – Partie 3-1: Utilisation des réseaux locaux sur paire torsadée avec signal de porteuse

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRICITY METERING DATA EXCHANGE – THE DLMS/COSEM SUITE –

Part 3-1: Use of local area networks on twisted pair with carrier signalling

FOREWORD

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International Standard IEC 62056-3-1 has been prepared by IEC technical committee 13: Electrical energy measurement and control.

This second edition cancels and replaces the first edition of IEC 62056-3-1, issued in 2013, and constitutes a technical revision.

The main technical changes with regard to the previous edition are as follows:

- addition of a profile which makes use of the IEC 62056 DLMS/COSEM Application layer and COSEM object model;
- review of the data link layer which is split into two parts:
  - a pure Data Link layer;
  - a "Support Manager" entity managing the communication media;
- ability to negotiate the communication speed, bringing baud rate up to 9 600 bauds.

The text of this International Standard is based on the following documents:

CDV	Report on voting
13/1794/CDV	13/1823/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts of IEC 62056 series, published under the general title *Electricity metering data exchange – The DLMS/COSEM suite*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

ELECTRICITY METERING DATA EXCHANGE – THE DLMS/COSEM SUITE –

Part 3-1: Use of local area networks on twisted pair with carrier signalling

1 Scope

This part of IEC 62056 describes two sets of profiles: the first set of profiles allows a bidirectional communication between a client and a server. This set of profiles is made of three profiles allowing local bus data exchange with stations either energized or not. For non-energized stations, the bus supplies energy for data exchange. Three different profiles are supported:

- base profile: this three-layer profile provides remote communication services;

  NOTE 1 This first profile was published in IEC 61142:1993 and became known as the Euridis standard.

- profile with DLMS: this profile allows using DLMS services as specified in IEC 61334-4-41;

  NOTE 2 This second profile was published in IEC 62056-31:1999.

- profile with DLMS/COSEM: this profile allows using the DLMS/COSEM Application layer and the COSEM object model as specified in IEC 62056-5-3 and in IEC 62056-6-2 respectively.

The three profiles use the same physical layer and they are fully compatible, meaning that devices implementing any of these profiles can be operated on the same bus. The transmission medium is twisted pair using carrier signalling and it is known as the Euridis Bus.

The second set of profiles allows unidirectional communication between a given Energy Metering device and a Customer Energy Management System. This second set is made up of three profiles.

Subclause 4.2.1 to Clause 8 included specify the bidirectional communication using twisted pair signalling and Clause 9 to 9.5 the unidirectional communication using twisted pair signalling.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 61334-4-41:1996, *Distribution automation using distribution line carrier systems – Part 4: Data communication protocols – Section 41: Application protocols – Distribution line message specification*

IEC 62056-51:1998, *Electricity metering – Data exchange for meter reading, tariff and load control – Part 51: Application layer protocols*

IEC 62056-5-3:2017, *Electricity metering data exchange – The DLMS/COSEM suite – Part 5-3: DLMS/COSEM application layer*

IEC 62056-6-2:2017, *Electricity metering data exchange – The DLMS/COSEM suite – Part 6-2: COSEM interface classes*

ISO/IEC 8482:1993, *Information technology – Telecommunications and information exchange between systems – Twisted pair multipoint interconnections*

EIA 485, *Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.2 Abbreviated terms

ADP	Primary Station Address
ADG	General Secondary Address. Broadcast Address
ADS	Secondary Station Address
AGN	Normal Wakeup
AGT	General call for a General Energized Station
APDU	Application Protocol Data Unit
APG	General Primary Address
ARJ	COM field value: Rejection of authentication in remote programming exchange
ASDU	Application Service Data Unit
ASO	COM field value: Call to Forgotten Stations
AUT	COM field value: Authentication command
COM	Control field of the Data Link layer
COSEM	Companion Specification for Energy Metering
DAT	COM field value: Response of remote reading exchange
DES	Data Encryption Standard
DLMS	Distribution Line Message Specification (IEC 61334-4-41) Device Language Message Specification (IEC 62056-5-3)
DSDU	Data link Service Data Unit
DRJ	COM field value: Data Rejected Value of COM notifying the rejection of remote programming exchange data
Dsap	Transport data unit label. Coded over 3 bits. Its value is 6.
DTSAP	Destination of Transport Service Access Point
ECH	COM field value: Echo of remote programming exchange data
ENQ	Remote reading exchange request
EOS	COM field value: End of remote programming exchange
IB	Initialisation of the bus
LDTI	Local Data Transmission Interface
MaxRetry	Maximum number retransmissions. Limited to 2.
MaxRSO	Maximum number of RSO listening windows. Fixed at 3.

PDU	Protocol Data Unit
PRE	COM field value: Pre-selection of energised stations
REC	COM field value: Remote programming exchange request
RSO	COM field value: Response to a call to forgotten stations
SEL	COM field value: Acknowledgement of the pre-selection of energized stations
STSAP	Source Transport Service Access Point
TAB	In the case of the EURIDIS profiles without DLMS and without DLMS/COSEM: data code. In the case of profiles using DLMS or DLMS/COSEM: value at which the equipment is programmed for Discovery
TABi	List of TAB field
TASB	Duration of an Alarm Signal on the Bus
TIC	Transmission of Information to the Customer
TOAG	Maximum wait time for an energized station once selected, to recognise a general call AGN
TOALR	Wait before sending an AGN after reception of an AGN or AGT
TOL	Maximum waiting time for a request from the upper layer
TOPRE	Maximum waiting time for a response to a pre-selection.
TOU	Time of Use
TPDU	Transport Protocol Data Unit
TSDU	Transport Protocol Service Unit
TRA	COM field value: Acknowledgement of point to point transfer
TRB	COM field value: Broadcast remote transfer frame not acknowledged
TRF	COM field value: Point to point remote transfer exchange
T1	Time out to wait for a response according to a request
XBA	COM field value: Response to a change of speed request
XBR	COM field value: Change of speed request
ZA1	Field reserved for bidirectional programming authentication
ZA2	Field reserved for bidirectional programming authentication

4 General description

4.1 Basic vocabulary

All communication calls upon two systems called Primary Station and Secondary Station. The Primary Station is the system that decides to initialize a communication with a remote system called Secondary Station; these designations remain valid throughout the duration of the communication.

A communication is broken down into a certain number of transactions. Each transaction consists of a transmission from the Transmitter to the Receiver. During the sequence of transactions, the Primary Station and Secondary Station systems take turns to act as Transmitter and Receiver.

For the local bus data exchange profile with DLMS or DLMS/COSEM, the terms Client and Server have the same meaning as for the DLMS model (refer to IEC 61334-4-41 or IEC 62056-5-3). The Server (which is a Secondary Station) receives and processes all submissions of specific service requests. The Client (which is a Primary Station) is the system that uses the Server for a specific purpose by means of one or more service requests.

4.2 Profiles, layers and protocols

4.2.1 Overview

This document specifies three profiles as shown in Figure 1.

- the base profile (without DLMS), see 4.2.2;
- the profile with DLMS, see 4.2.3;
- the profile with DLMS/COSEM; see 4.2.4.

The physical layer in the three profiles is the same except that in the DLMS/COSEM profile speed negotiation is available. This common physical layer allows stations using different profiles to be installed on the same bus.

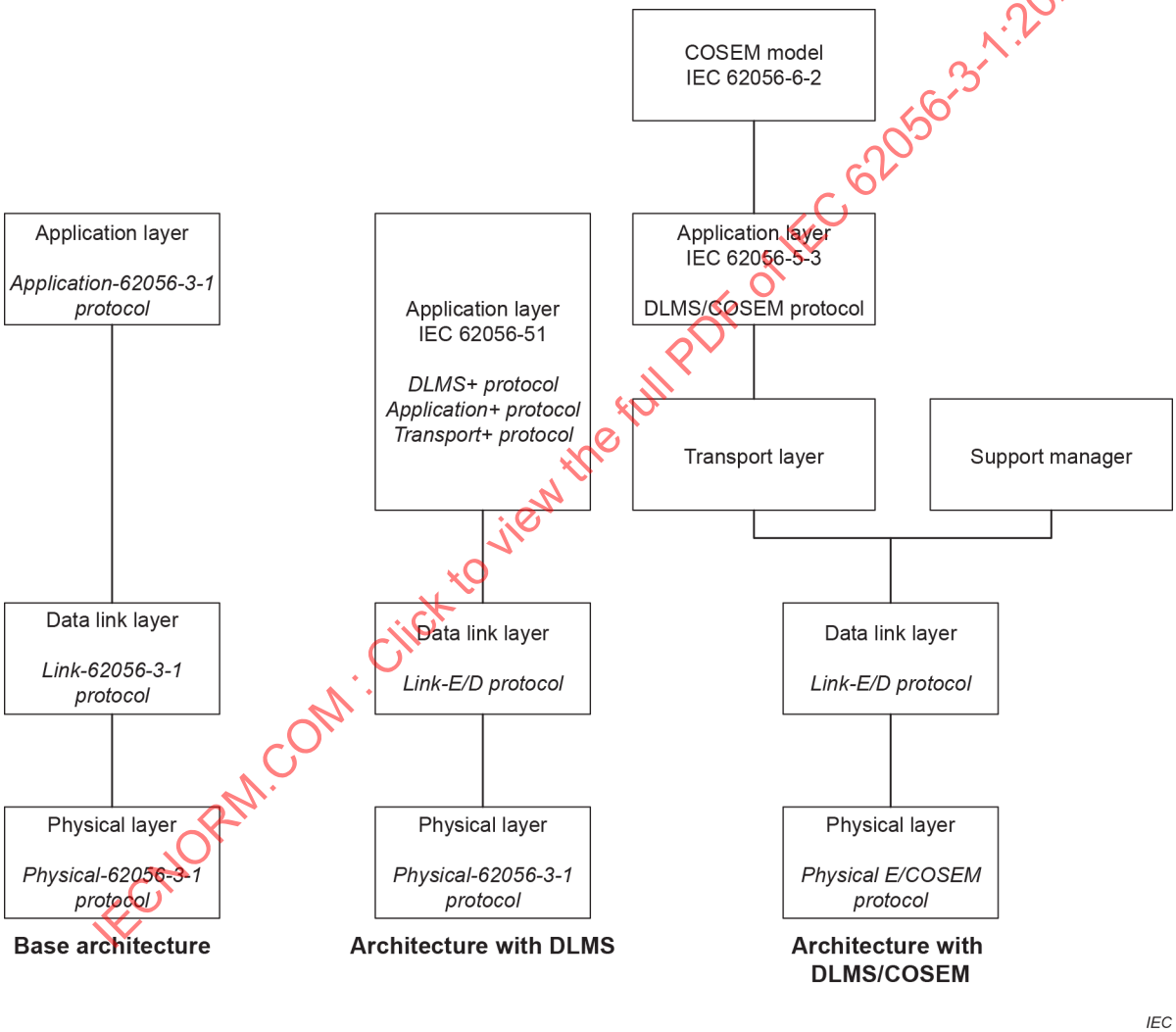


Figure 1 – IEC 62056-3-1 communication profiles

4.2.2 Base profile (without DLMS)

The base profile (without DLMS) uses three protocol layers:

- the physical layer with the *Physical-62056-3-1* protocol specified in 5.1;
- the data link layer with the *Link-62056-3-1* protocol, specified in 5.2, and
- the application layer with the *Application-62056-3-1* protocol specified in 5.3.

This profile allows remote reading, remote programming, point-to-point remote transfer – which is a simplified remote programming service – broadcast remote transfer, remote supply of secondary stations, detecting forgotten stations and alarm functions. The related communication services are specified in 4.4.

4.2.3 Profile with DLMS

The profile with DLMS uses three protocol layers:

- the same physical layer as the base profile, specified in 5.1;
- the data link layer using the *Link-E/D* protocol, specified in 6.2; and
- the application layer specified in IEC 62056-51, using the *Transport+, Application+* and *DLMS+* protocols, see 6.3.

This profile also allows using DLMS as specified in IEC 61334-4-41. The related communication services are specified in 4.5.

4.2.4 Profile with DLMS/COSEM

The profile with DLMS/COSEM uses four protocol layers:

- the physical layer, similar to the one used in the base profile and the profile with DLMS, specified in 5.1, but with speed negotiation, see 7.2;
- the data link layer using the *Link-E/D* protocol. This is the same as the data link layer of the profile with DLMS, except that it interfaces with the support manager layer and the transport layer. See 7.3;
- the support manager layer supports some specific process for the management of the bus, see 7.4;
- the transport layer provides segmentation and reassembly of APDUs, see 7.5;
- the application layer as specified in IEC 62056-5-3 taking into account some restrictions of the Euridis bus, see 7.6.

The profile with DLMS/COSEM allows using the COSEM object model and the DLMS services accessing the COSEM objects over the Euridis bus.

4.3 Specification language

In this document, the protocol of each layer is described by state transitions represented in the form of tables. The syntax used in making up these tables is defined by a specification language described in Annex A.

In the event of a difference in interpretation between part of the text and a state transition table, the table is always taken as the reference.

4.4 Communication services for local bus data exchange without DLMS

4.4.1 Overview

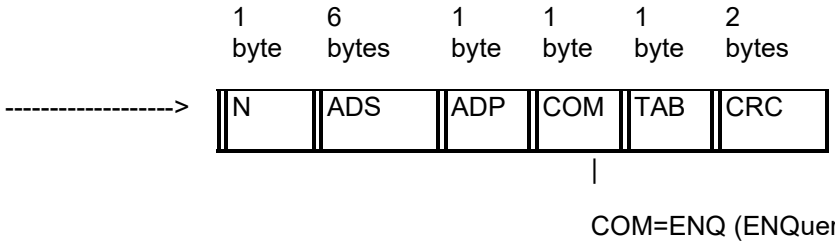
The list of available services (see Annex I) at the Application level layer is:

a) remote reading of data, see 4.4.2;
b) remote programming of data, see 4.4.3;
c) point to point remote transfer, which is a simplified remote programming service, see 4.4.4;
d) broadcast remote transfer, 4.4.5;
e) bus initialization, 4.4.6;
f) forgotten station call, 4.4.7.

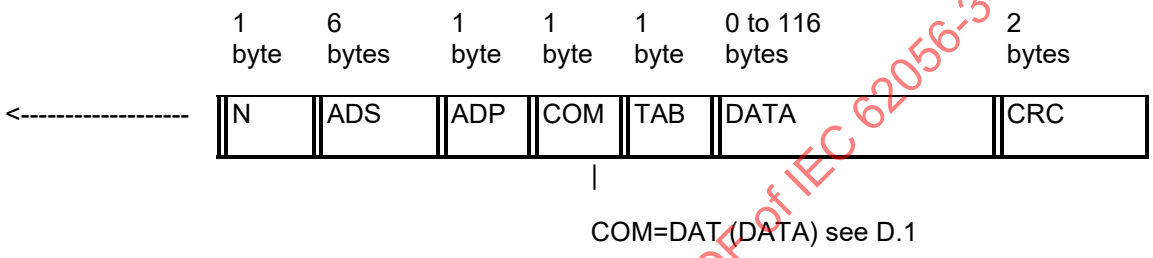
4.4.2 Remote reading exchange

The ENQ exchange consists of two frames arranged in one sequence:

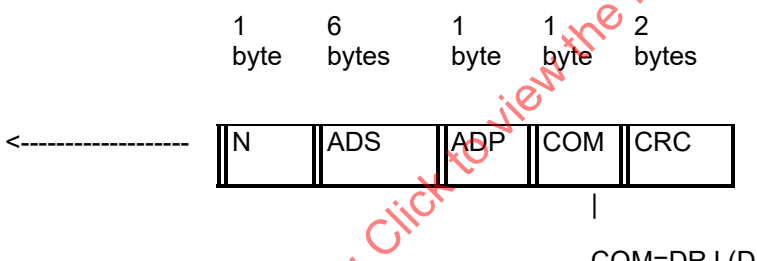
- remote reading frame containing the type of data to select in the TAB field



- positive acknowledgement frame with the selected data in the DATA field



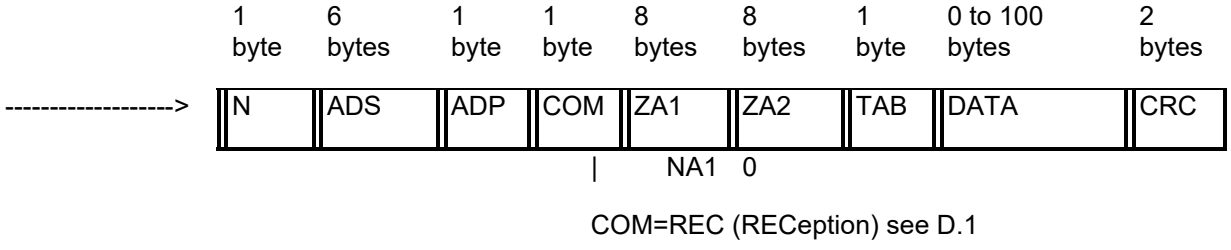
- negative acknowledgement frame (TAB identifier unknown)



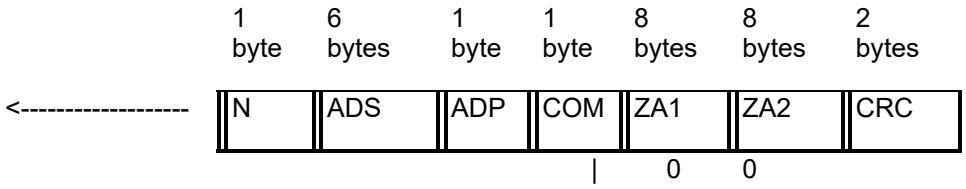
4.4.3 Remote programming exchange

The REC exchange consists of four frames arranged in two sequences. Since there is an internal sequence for authentication purpose, from the application point of view, it seems to be only one sequence with two frames:

- remote programming frame containing data in the DATA field and their type in the TAB field

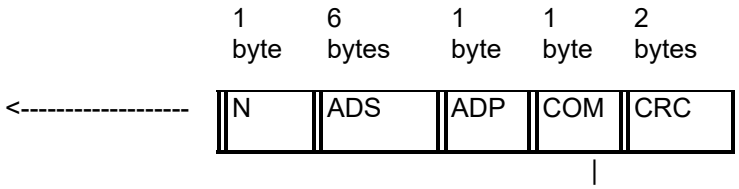


- positive acknowledgement frame (no authentication trouble)



COM=EOS (End Of Session) see D.1

- negative acknowledgement frame (no authentication trouble but remote programming data not validated)



COM=DRJ (Data ReJected) see D.1

Authentication is carried out by an exchange of random numbers ciphered using a secret key specific to each Secondary Station. The random numbers are defined in 8 bytes and they are ciphered with the DES algorithm using an 8-byte ciphering key Ki known both to the Primary and the Secondary station.

A random number NA1 is first generated by the Primary Station and transmitted into the ZA1 field of the remote programming frame while field ZA2 is set to zero.

On arrival at the Secondary Station, field ZA1 is ciphered by the DES algorithm with key Ki to get the ciphered random number NA1K. Then occurs the internal sequence for authentication which consists of two frames.

The first frame (from Secondary to Primary Station) contains this random number NA1K in field ZA1 and a random number NA2 generated by the Secondary station in field ZA2.

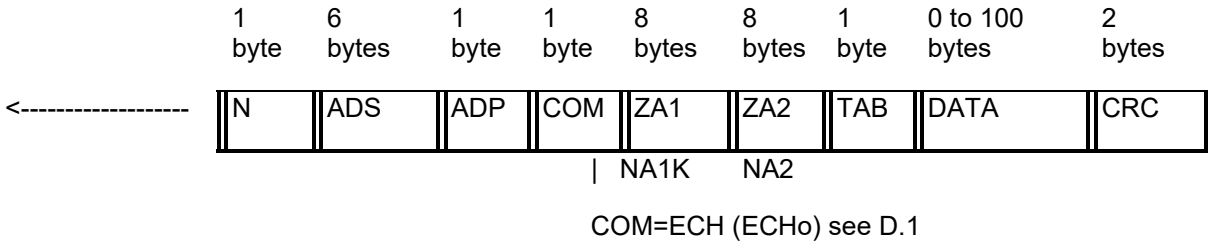
On reception of this frame, the Primary Station compares the ZA1 field to an NA1´ number obtained by ciphering the transmitted NA1 number using the DES algorithm with key Ki. If NA1´ = ZA1, then the Primary Station considers the called Secondary Station as authenticated. Otherwise, it considers the Secondary Station has not been authenticated and aborts the communication session.

After correct authentication of the Secondary Station, the Primary Station first ciphers the random number NA2 by the DES algorithm with key Ki to get the ciphered random number NA2K and then transmits it into field ZA2 while field ZA1 is set to zero.

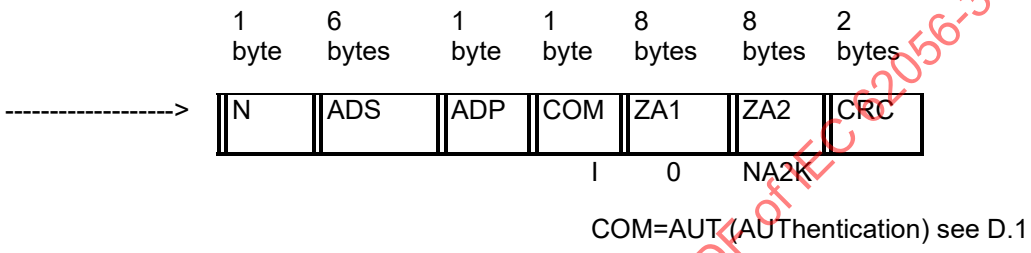
On reception of this response frame, the Secondary Station compares the ZA2 field to an NA2´ number obtained by ciphering the transmitted NA2 number using the DES algorithm with key Ki. If NA2´ = ZA2, then the Secondary Station considers the Primary Station as authenticated. Otherwise, it considers the Primary Station has not been authenticated and sends a negative acknowledgment frame.

The internal authentication exchange is the following:

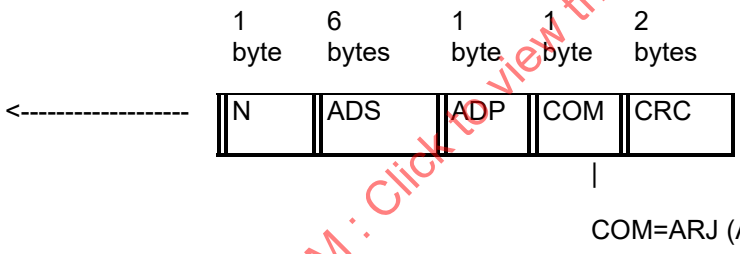
- internal authentication frame containing the ciphered random number NA1K in field ZA1 and the random number NA2 in field ZA2



- positive response frame containing the ciphered random number NA2K in field ZA2 (if the Secondary Station is considered as authenticated)



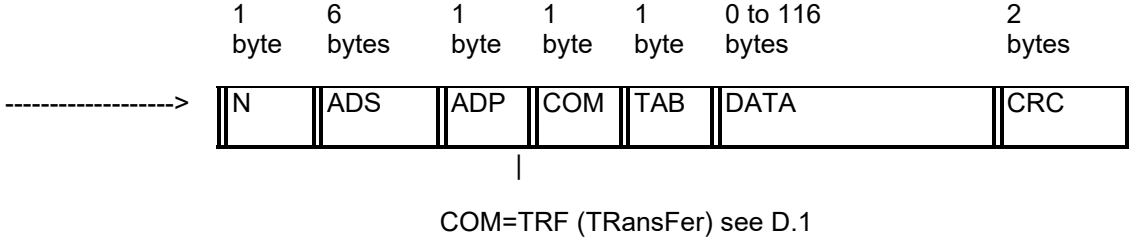
- an authentication rejection frame replaces the normal EOS or DRJ frame when the Primary Station is not considered authenticated



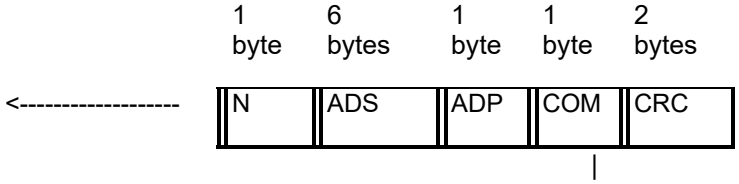
4.4.4 Point to point remote transfer exchange

This TRF exchange consists of two frames arranged in one sequence. From the application point of view, it seems to be a remote programming exchange in a single sequence with no authentication:

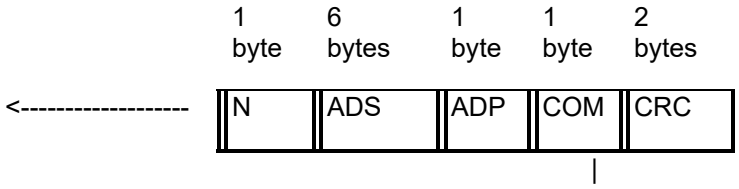
- point to point remote transfer frame containing data in the DATA field and their type in the TAB field



- positive acknowledgement frame



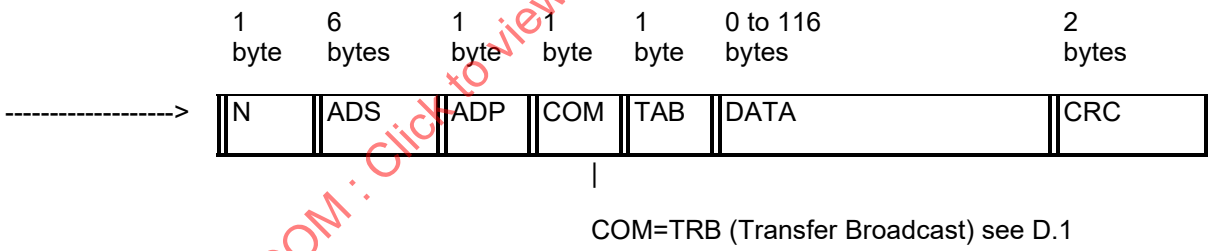
- negative acknowledgement frame (remote transfer data not validated)



4.4.5 Broadcast remote transfer frame

This TRB frame does not involve any frame answer. From the application point of view, it seems to be a point to point remote transfer, but without acknowledgement since it is a broadcast.

- broadcast remote transfer frame containing data in the DATA field and their type in the TAB field

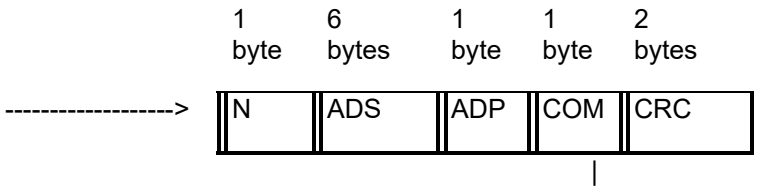


The secondary address (which defines the receiving Secondary Stations) shall be a broadcast address.

4.4.6 Bus initialization frame

This IB frame does not involve any frame answer. From the application point of view, it seems to be a broadcast remote transfer, but without data since its purpose is only to reset a special flag (called forgotten station flag) to TRUE for all Secondary Stations that have been programmed with the ADP address:

- bus initialization frame



The secondary address (which defines the receiving Secondary Stations) shall be a broadcast address.

After the bus initialization frame, any Secondary Station receiving a correct ENQ frame containing a known TAB identifier will then no longer be considered as a "forgotten station".

4.4.7 Forgotten station call exchange

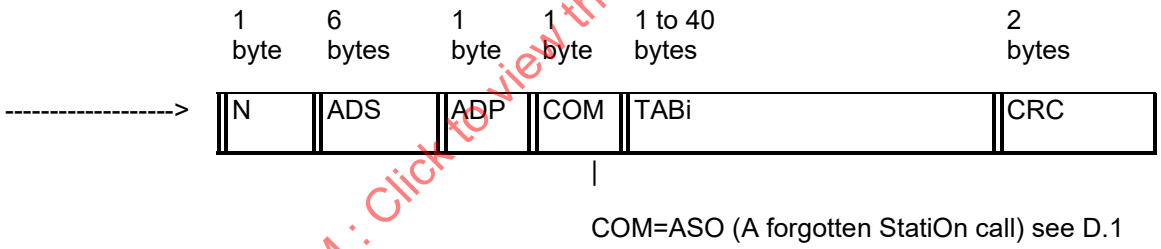
This ASO exchange consists of two frames arranged in one sequence. At the end of a remote reading sequence, the Primary Station can search for stations whose forgotten station flag is TRUE (maximum 5 in 100).

As a correct remote reading exchange sets the forgotten station flag of the corresponding station to FALSE, the ASO exchange normally occurs after the completion of a remote reading sequence that is one or several remote reading exchanges preceded by a bus initialization frame.

The Primary Station manages several time slots. When detecting a collision, it has to retry an ASO exchange. Nevertheless, each time a correct Secondary Station answer is received, the Primary Station shall eliminate it from the list of forgotten stations by operating a correct remote reading exchange with this station.

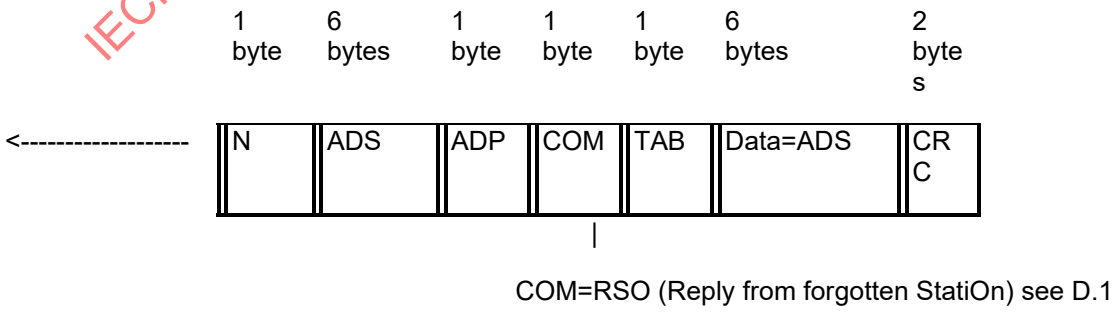
In order to ensure the selection constraints (described in 4.4.9), the non-energized stations shall answer in the first time slot of the first ASO exchange. Then, only the forgotten stations are selected and the usual principle can be used for the following ASO exchanges.

- forgotten station call frame containing selection criteria in the TABi field (1 to 40 TAB identifiers)



The secondary address (which defines the receiving Secondary Stations) should be a broadcast address.

- acknowledgement frame containing the first TAB recognized by the unit and the ADS of the station



- The data field containing the ADS of the secondary station responds to the call to forgotten stations.

4.4.8 Frame fields

N total number of bytes in the frame, including N.

ADS absolute physical address of the Secondary Station coded as a 48-bit string. There is only one broadcast physical address which is the general broadcast ADG coded as "000000000000"in hexadecimal [1].

The ADS also corresponds exactly to the System Title of the Secondary Station.

ADP physical address of the Primary Station coded as an 8-bit string. The value "00"H is reserved for the coding of the physical address of the general primary APG [2]. Any Secondary Station solicited by a Primary Station whose physical address is APG, replies with the first primary physical address with which it has been programmed.

COM command code depending on the exchange and the frame direction (see Annex D).

ZA1, ZA2 fields reserved for authentication operated during the remote programming exchange.

TAB type of data selected associated with some command codes (ENQ, DAT, REC, TRF, TRB or RSO). The value "00"H is reserved for systems management, the value "FF"H for alarm management.

DATA information packet from the host application. This field can be eventually empty depending on the command code.

CRC Cyclic Redundancy Check field corresponds to the 16 redundant bits of the CRC whose principle is described in Annex E.

The frame fields are transmitted in an ascending order (from N to CRC). When a field contains data over several bytes, the transmission begins with the least significant byte and ends with the most significant one. However, the DATA field is considered as a byte string and is transmitted in an ascending order.

4.4.9 Principle of the energy remote supply

The general principle of the data exchanges is preserved for the non-energized stations. The notion of energy remote supply is only added for communication between a Primary Station and one or more Secondary Stations.

To begin a communication session, the Primary Station should send a "Wakeup Call" designed to alert the communications system of every Secondary Station connected to the bus. This call is a continuous carrier for a nominal time depending on the energy remote supply mechanism:

- the "Wakeup Call" signal duration is AGT to wake up non-energized stations;
- the "Wakeup Call" signal duration is AGN to wake up energized stations.

Remark: A Secondary Station can be configured in Alarm mode. It is then remote supplied continuously and so can transmit the alarm to the Primary Station (see 4.4.11).

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[1] Other broadcast addresses could be defined depending on the naming rules adopted in companion standards for the semantics of the System Titles which are often based on a manufacturer code, a manufacture year and an equipment type.

[2] Other general addresses could be defined depending on the naming rules adopted in companion standards for the semantics of operator identifiers which are often based on a utility code.

Then, whatever type of remote station is selected (energized or not), an intermediate AGN "Wakeup Call" signal shall also be required at the Primary Station side in the following circumstances:

- before the first ENQ or TRF exchange;
- before the sixth consecutive and successful ENQ or TRF exchange with the same Secondary Station;
- before the first ENQ or TRF exchange with a different Secondary Station to the one previously selected in the preceding ENQ or TRF exchange;
- before any REC exchange;
- before any TRB frame;
- before any IB frame;
- before any ASO exchange.

For non-energized stations, it means that the Primary Station can avoid to wake up all the remote stations when not necessary, and then save its energy.

A Primary Station can use a specific modem ensuring both the energy remote supply as well as the modulation and demodulation functions. The communication time and the number of non-energized stations shall be optimized in order to save the battery of the Primary Station.

As another possibility, the Primary Station might only focus on the modulation and demodulation functions. In this case, an auxiliary station continuously supplies the bus with energy.

A Secondary Station generally contains only one logical application referenced by its ADS. Such a station may or may not be energized.

A multiple Secondary Station (containing several logical applications corresponding to several ADSs) should be a non-energized station. This feature is described more fully in Clause 8.

4.4.10 Non-energized station preselection exchange

To optimize the bus consumption, a preselection exchange enables the Primary Station to select a non-energized Secondary Station.

The preselection exchange occurs after an AGT "Wakeup Call" signal addressed to all non-energized stations of the bus. To limit the bus consumption, the first frame sent by the Primary Station should be short enough and the addressed Secondary Station should answer before the triggering of the TOPRE wakeup. Not seeing an answer in time, the modem of the Secondary Station goes back in a low consumption state.

During the preselection exchange, all the non-energized stations consume energy. The bus voltage and the energy storage capacitors decrease until the non-selected stations goes back in a low consumption state. Then the continuously sent energy charges the energy storage capacitors and the bus voltage increases.

The modem of the Primary Station should store sufficient energy before the first preselection. This step is guaranteed by a wait-time controlled thanks to the TICB wakeup. At the end of a preselection, the energy storage capacitors are empty and the Primary Station shall wait for the bus voltage increase before a second preselection.

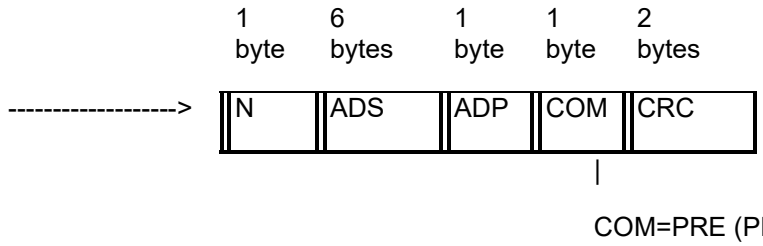
As the preselection frame shall not be more than 18 bytes long, it can be:

- an ENQ frame;
- a TRB or TRF frame, if and only the data field is less than or equal to 6 bytes long;

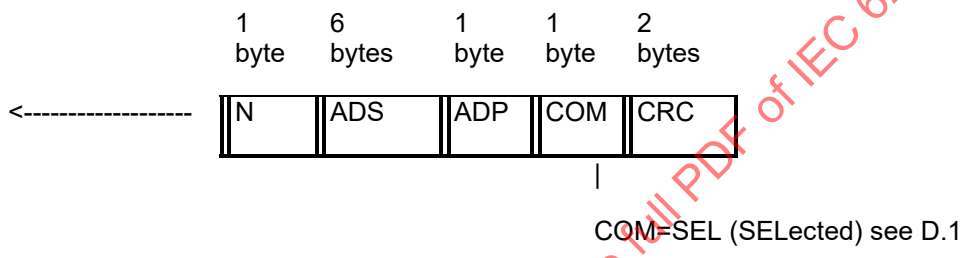
- an IB frame;
- an ASO frame, if and only the number of TABi fields is less than or equal to 7.

As the first frame of REC and TRF exchanges may be too long, an additional service is provided for preselection. This fully transparent preselection exchange consists of two frames arranged in one sequence.

- non-energized station preselection frame



- acknowledgement frame



To save the energy of the Primary Station, there is no retry during a preselection exchange. If an addressed non-energized station does not answer correctly, it is not selected and the Primary Station shall send a new AGT "Wakeup Call" signal.

4.4.11 Communication exchange after preselection

After preselection, the modem of a non-energized station can stay awake for the continuing communication and delays are not critical since the number of connected devices is limited. The Primary Station supplies the selected station and charges the capacitive reservoirs of the non-selected stations.

The normal end of the communication session occurs differently depending on the energy remote supply mechanism:

- after a short period of inactivity during the communication session when no intermediate AGN "Wakeup Call" signal is required for energized stations. This period is checked by the wakeup TOL;
- after a longer period of inactivity during the communication session for non-energized stations. This period is checked by the wakeup TOAG.

Note that for a non-energized station, as far as there is no timeout of TOAG wakeup, an intermediate AGN "Wakeup Call" signal is enough to go on the current communication session.

4.4.12 Alarm function

A device integrated in a simple or multiple Secondary Station (see 8.2.3) can transmit alarms to the primary station, providing it can integrate functions of interface as described hereinafter.

An alarm shall be fetched from the Secondary Station in 10 s maximum.

A programmable configuration on the Interface and one on each device selects the status of Alarm mode: Active or Inactive.

When Alarm mode is active, the device can generate an alarm, inside the secondary station. The Alarm function is effective only if the supply is present and permanent on the bus.

The device sends the alarm during TASB. TASB is long enough to force an "0" state on the secondary bus and to be detected by the Interface, even if a communication is in progress.

Alarm mechanism is described in Figure 2.

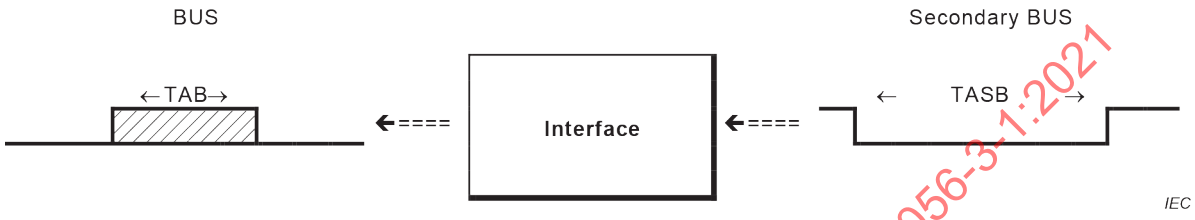


Figure 2 – Alarm mechanism

The alarm is not directly transmitted towards the primary station. The interface receives the alarm and transmits it by sending a "0" (50 kHz carrier) during TAB on the bus when it is possible:

a) No communication on the bus.

   When the interface receives the alarm on the secondary bus, it transmits it on the bus.

b) On synchronization of AGN or AGT when a communication is in progress. When a communication is in progress on the bus, the Interface memorises the alarm received. It transmits it to the bus after one of the following events:

   - TOALR after the end of AGN or AGT reception;
   - when the normal end of the communication session occurs.

In this way, the interface can filter the alarm to avoid conflict on the bus.

After the alarm generation, the Secondary Station will be considered as a "forgotten station" with a selection criterion equal to FF.

The primary station configured in Alarm mode listens to the bus when there is no communication on the bus and after transmission of an AGN or AGT in order to detect an alarm. When the primary station receives an alarm, it enters in Forgotten Station Call procedure with a selection criteria in the TABi field equal to FF (see 4.4.7).

Timing diagrams explain Alarm management in 5.1.3.

4.5 Communication services for local bus data exchange with DLMS

DLMS does not offer services to operate the bus initialization and forgotten station call mechanisms. Nevertheless, the IB frame and the ASO exchange are supported and managed as they are with the local bus data exchange profile without DLMS except that the forgotten station flag is considered as a global variable shared with the Application Programming Interface.

Remote reading of data and point to point remote transfer are directly foreseen by DLMS. But the (redundant) remote programming of data is not supported since authentication is reserved for the *Application* layer.

As data semantics is managed by DLMS, the frame format is very simple and only unmarked frames are required. To ensure compatibility with the profile without DLMS, this frame format is defined by the following nine fields:

1 byte	6 bytes	1 byte	3 bits	1 bit	2 bits	2 bits	0 to 117 bytes	2 bytes
Size	ADS	ADP	DATA+	Priority	Send	Confirm	Text	CRC

Size total number of bytes in the frame, including Size. If its value is not 11, the Receiver knows that the frame contains data in the Text field

ADS same rules as for local bus profile without DLMS

ADP same rules as for local bus profile without DLMS

DATA+ always coded "111"B

Priority transmission priority level of the current frame. The *Application* layer sets this priority according to the requested service

Send number of the last frame sent

Confirm number of the last frame received without error

Text DSDU (Data link Service Data Unit) from the higher level. A frame does not necessarily contain text. If data from the *Application* layer is available when the frame is sent, then the *Text* field will contain data, otherwise it will be empty. This mechanism provides the conditions for balanced bi-directional data transmission. In order not to confuse DATA+ frame with frames from the profile without DLMS, the DATA+, Priority, Send and Confirm fields make up a special command code COM whose values are different from the already reserved COM values (see Annex D)

CRC same rules as for local bus profile without DLMS

The frame fields are transmitted in ascending order (from Size to CRC). When a field is coded on several bytes, the transmission begins with the least significant byte and ends with the most significant one. However, the Text field is considered as a byte string and transmitted in ascending order.

4.6 Systems management

The purpose of Systems management is to allow an enrolment. This enrolment includes an identification of Secondary Stations on a bus. The Discover service is provided for this purpose.

The enrolment consists of a sequence of Discover requests issued by the active initiator located inside the Primary Station. Each Discover service is provided to inform the remaining new stations that they will have a chance to respond in the next time slots.

A Discover request conveys a specific response-probability argument as an integer in the range [0, 100]. It expresses the probability, in per cent, that a new station responds. When it is set to 100, all the new stations on the bus shall respond.

On reception of a Discover indication, each Secondary Station tests the value of its flag Discovered. If it is set to TRUE, the indication is discarded; otherwise it draws a random number between 1 and 100. If this number is smaller than or equal to the response-probability argument, the new station will issue a Discover response and set its flag Discovered to TRUE.

The flag Discovered is always reset on a receiving of an IB frame.

To ensure a maximum compatibility (for stations including DLMS/COSEM, DLMS or otherwise), it is proposed to implement the systems management as indicated in Annex H.

5 Local bus data exchange without DLMS

5.1 Physical layer

5.1.1 Physical-62056-3-1 protocol

The *Physical-62056-3-1* protocol of the *Physical* layer of the local bus data exchange profile without DLMS behaves asymmetrically. The state machine of the Primary Station is therefore different from that of the Secondary Station.

The *Physical-62056-3-1* protocol supports the Secondary Stations whether or not they are energized. As already stated in the general description, the remote stations are woken up either by an AGN or an AGT "Wakeup Call" signal and a communication session ends after expiry of TOL or TOAG wakeup.

After a "Wakeup Call" signal, a communication session is then made asynchronously and by half-duplex at 1 200 bits/s on the bus.

5.1.2 Physical parameters

The value of the maximum size of a frame being received, MaxIndex, is set to 128.

The value of the maximum number of RSO time slots for the processing of a "Forgotten Stations Call", MaxRSO, is set to 3.

The AGN duration of an AGN "Wakeup Call" signal shall be in the range [50, 150[ms, while the AGT duration of an AGT "Wakeup Call" signal shall be in the range [200, 300[ms.

Timing type and characteristics are described in Annex B.

The values of Table 1 are defined for a Primary Station.

Table 1 – Primary Station timing

	Min. ms	Nominal ms	Max. ms	See Type B.1	Definition
TA10	–	–	120	TSL1	Maximum waiting period of the first byte of a frame being received
TAB		100		TC	Duration of an alarm signal on the bus
TAGN	–	100	–	TPDF	Duration of an AGN "Wakeup Call" signal
TAO	–	–	40	TC	Maximum waiting period of one byte of a frame being received whose expiry indicates the end of a frame
TARSO	–	500	–	TC	Length of an RSO time slot
TASB		1 200		TC	Waiting period after the beginning of an alarm signal
TEMPO	–	40	–	TC	Safety delay at the end of transmission of a Wake up signal or a frame
TOE	–	–	2 500	TL	Safety delay for transmitting to protect against defective hardware
TOL	–	–	100	TSL2	Maximum waiting time for a request coming from the upper layer
T1	_	10 000	_	TL	Maximum waiting time for a response from the secondary station
Non-energized station specific (Supply)					
TAGT	–	250	–	TPDF	Duration of an AGT "Wakeup Call" signal
TICB	8 000	–	–	Ta	Initial bus charge period
TOAG	–	–	3 000	TPFD	Maximum delay for a selected non-energized station to recognize an AGN "Wakeup Call" signal

The values of Table 2 are defined for a Secondary Station.

Table 2 – Secondary Station timing

	Min. ms	Nominal ms	Max. ms	Type[a]	Definition
TA1O	30[b]	–	160	TSL1	Maximum waiting period of the first byte of a frame being received
TAB		100	–	TC	Duration of an alarm signal on the bus
TAGN	50	100	150	TPDF	Duration of an AGN "Wakeup Call" signal
TAO	–	–	40	TC	Maximum waiting period of one byte of a frame being received whose expiry indicates the end of a frame
TARSO	–	–	500	TC	Length of an RSO time slot
TOALR	20	–	–	TL	Waiting to send an AGN after an AGN or AGT reception
TOE	–	–	2 500	TL	Safety delay for transmitting to protect against defective hardware
TOL	–	–	100	TSL2	Maximum waiting time for a request coming from the upper layer
Non-energized station specific (Supply)					
TAGT	200	250	300	TPDF	Duration of an AGT "Wakeup Call" signal
TASB	–	1 200	–	TL	Duration of a secondary-bus alarm signal
TICB	8 000	–	–	Ta	Initial bus charge period
TOAG	–	–	3 000	TPFD	Maximum delay for a selected non-energized station to recognize an AGN "Wakeup Call" signal
TOAGN	–	–	300	Tc	Maximum delay of inactivity to recognize the end of a communication session with an energized station
TOAPPEL	–	–	180	TPFD	Maximum waiting period of the first byte of a preselection frame being received
TOBAVARD	–	–	260	TPDF	Safety delay to protect against defective length of preselection frame
TOPRE	–	–	130	TPFD	Maximum waiting for a preselection answer
TOSEUIL	–	150	–	TC	Duration of a "Wakeup Call" signal which wakes up a non-energized station
TVASB	40	–	–	TL	Minimum duration of an alarm signal on the secondary bus

[a] For the definition of different timing types, see Clause B.1.

[b] After a "Wakeup Call" a minimum duration of 30 ms is necessary.

5.1.3 Timing diagrams

Figure 3, Figure 4 and Figure 5 can be used to show different types of session of the protocol for non-energized secondary stations.

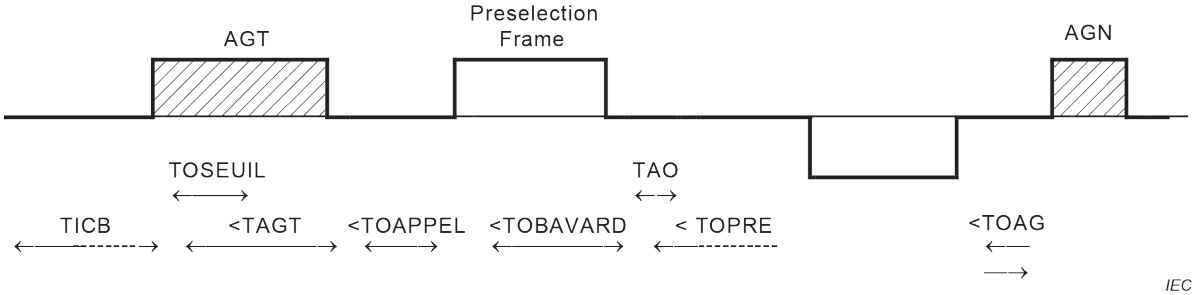


Figure 3 – Exchanges in continuous operation

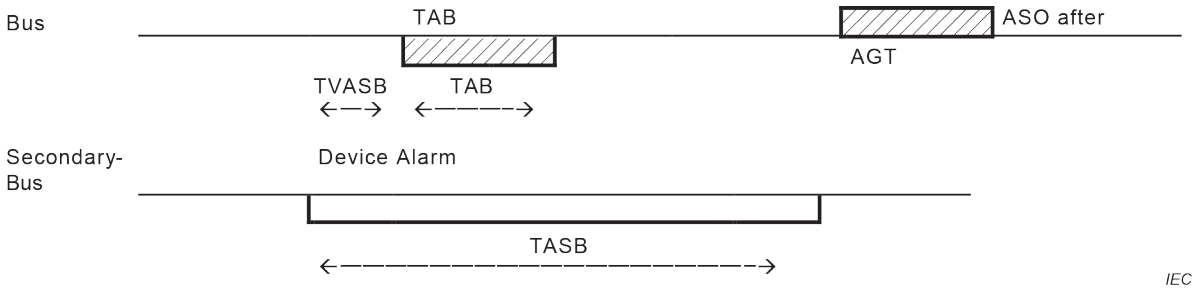


Figure 4 – Alarm event without any communication in progress

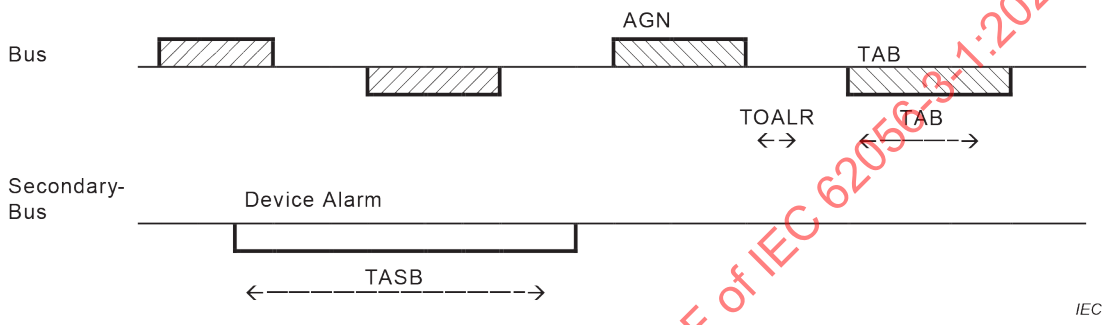


Figure 5 – Alarm event with a communication in progress

5.1.4 Physical services and service primitives

The user of the *Physical-62056-3-1* protocol can use the services and service primitives given in Table 3.

Table 3 – Physical services and service primitives

Service	Service primitive
Phy_DATA	Phy_DATA.req(Frame) Phy_DATA.ind(Frame)
Phy_UNACK	Phy_UNACK.req(Frame)
Phy_APPG	Phy_APPG.req(TypeAG) Phy_APPG.ind()
Phy_ASO	Phy_ASO.req(Frame) Phy_ASO.ind(Frame)
Phy_RSO	Phy_RSO.req(Frame, Window)
Phy_COLL	Phy_COLL.ind()
Phy_ALARM	Phy_ALARM.req() Phy_ALARM.ind()
Phy_ABORT	Phy_ABORT.req() Phy_ABORT.ind(ErrorNb)

The role assigned to each primitive is as follows:

- Phy_DATA.req(Frame) enables the *Data Link* layer to request the *Physical* layer to transmit a frame Frame;
- Phy_DATA.ind(Frame) enables the *Physical* layer to inform the *Data Link* layer that a frame Frame is available;

- Phy_UNACK.req(Frame) enables the *Data Link* layer to request the *Physical* layer to transmit a frame Frame without waiting for acknowledgement;
- Phy_APPG.req(TypeAG) enables the *Data Link* layer to request the *Physical* layer to transmit a "Wakeup Call" signal. The duration TypeAG of this signal is either AGN or AGT;
- Phy_APPG.ind() enables the *Physical* layer to inform the *Data Link* layer of the end of the transmission of a "Wakeup Call" signal;
- Phy_ASO.req(Frame) enables the *Data Link* layer to request the *Physical* layer to transmit a "Forgotten Stations Call" frame;
- Phy_ASO.ind(Frame) enables the *Physical* layer to inform the *Data Link* layer that a frame Frame has been received in one of the time slots of the forgotten stations;
- Phy_RSO.req(Frame, Window) enables the *Data Link* layer to request the *Physical* layer to transmit a Forgotten Stations Call frame Frame in the time slot number Window;
- Phy_COLL.ind() enables the *Physical* layer to inform the *Data Link* layer that a collision has been detected in one of the time slots of the forgotten stations;
- Phy_ALARM.req() enables the *Data Link* layer to request the *Physical* layer to transmit an Alarm;
- Phy_ALARM.ind() enables the *Physical* layer to inform the *Data Link* layer of the arrival of an alarm;
- Phy_ABORT.req() enables the *Data Link* layer to request the *Physical* layer to end its activity;
- Phy_ABORT.ind(ErrorNb) enables the *Physical* layer to inform the *Data Link* layer of the occurrence of a fatal error identified by the number ErrorNb.

5.1.5 State transitions

The *Physical-62056-3-1* state transitions are as specified in Table 4, Table 5, Table 6, Table 7 and Table 8.

Table 4 – *Physical-62056-3-1* state transitions: Primary Station

Initial state	Triggering condition	Set of actions	Final state
Initial	$true()	MaxRSO=3 MaxIndex=128 Collision=FALSE SessionAGT=FALSE wait_time(TICB)	Stopped
Stopped	Phy_APPG.req(AG) & AG=AGN	stop_timer(TOAG) FlagAbort=FALSE TypeAG=AGN send_AG(TypeAG)	W.AG
Stopped	Phy_APPG.req(AG) & AG=AGT	SessionAGT=TRUE FlagAbort=FALSE TypeAG=AGT send_AG(TypeAG)	W.AG
Stopped	time_out(TOAG)	Phy_ABORT.ind(EP-2) SessionAGT=FALSE	Stopped
Stopped	Phy_ABORT.req()	$none()	Stopped
Stopped	data-carrier_on	init_timer(TAB) init_timer (TASB)	W.ETABS
W.ETABS	data_carrier_off	stop_timer(TASB) stop_timer(TAB)	Stopped
W.ETABS	time_out(TAB)	Phy_ABORT.ind(EP-3) Phy_ALARM.ind()	W.TASB
W.AG	AG_sent_event	Phy_APPG.ind() init_timer(TEMPO)	W.TAB

Initial state	Triggering condition	Set of actions	Final state
W.AG	Phy_ABORT.req()	FlagAbort=TRUE	W.AG
W.TAB	data-carrier_on	Carrier = TRUEinit_timer(TAB) init_timer (TASB)	W.TAB
W.TAB	data-carrier_off	Carrier = FALSE stop_timer(TAB) stop_timer (TASB)	W.TAB
W.TAB	time_out(TEMPO) & not(FlagAbort) & not(Carrier)	init_timer(TOL)	M.Send
W.TAB	time_out(TEMPO) & FlagAbort & not(Carrier)	wait_time (TOL)	*T.Session*
W.TAB	time_out(TEMPO) & Carrier	init_timer(TOL)	W.ETAB
W.TAB	Phy_ABORT.req()	FlagAbort=TRUE	W.TAB
W.ETAB	time_out(TAB)	Phy_ABORT.ind(EP-3) Phy_ALARM.ind() stop_timer(TOL)	W.TASB
W.ETAB	data_carrier_off & not(FlagAbort)	stop_timer(TAB) stop_timer (TASB)	M.Send
W.ETAB	data_carrier_off & FlagAbort	stop_timer(TAB) stop_timer (TASB)	W.TOL
W.ETAB	Phy_ABORT.req()	FlagAbort=TRUE	W.ETAB
W.TASB	time_out(TASB)	$none()	Stopped
W.TOL	time_out(TOL)	$none()	*T.Session*
M.Send	Phy_DATA.req(Frame)	Service=NORMAL	*SendFirst*
M.Send	Phy_UNACK.req(Frame)	Service=UNACKNOWLEDGED	*SendFirst*
M.Send	Phy_ASO.req(Frame)	Service=ASO	*SendFirst*
M.Send	Phy_ABORT.req()	$none()	M.Send
M.Send	time_out(TOL)	$none()	*T.Session*
T.Session	SessionAGT=TRUE	init_timer(TOAG) Phy_ABORT.ind(EP-1) wait_time(TEMPO)	Stopped
T.Session	SessionAGT=FALSE	Phy_ABORT.ind(EP-1) wait_time(TEMP0)	Stopped
SendFirst	$true()	stop_timer(TOL) Size=size(Frame) Index=1 send_octet(Frame, Index) Size=Size-1 init_timer(TOE)	Sending
Sending	octet_sent_event & Size>0	Index=Index+1 send_octet(Frame, Index) Size=Size-1	Sending
Sending	octet_sent_event & Size=0	stop_timer(TOE) wait_time(TAO) Index=1 Frame=""	*Answer*
Sending	Phy_ABORT.req()	stop_timer(TOE) wait_time(TAO) init_timer(TA1O) FlagAbort=TRUE	M.Rec
Sending	time_out(TOE)	Phy_ABORT.ind(EP-3F) wait_time(TAO) init_timer(TA1O) FlagAbort=TRUE	M.Rec
Answer	Service=NORMAL I Service=UNACKNOWLEDGED	init_timer(TA1O)	M.Rec
Answer	Service=ASO	WinRSO=1 init_timer(TARSO) init_timer(TA1O)	M.Rec

Initial state	Triggering condition	Set of actions	Final state
M.Rec	octet_received_event	stop_timer(TA1O) Index=Index+1 read_data(RecB) concat(Frame, RecB) init_timer(TAO)	Receiving
M.Rec	collision_detected_event	stop_timer(TA1O) Collision=TRUE init_timer(TAO)	Receiving
M.Rec	time_out(TA1O)	$none()	*Received*
M.Rec	Phy_ABORT.req()	FlagAbort=TRUE	M.Rec
Receiving	octet_received_event & Index<=MaxIndex	stop_timer(TAO) Index=Index+1 read_data(RecB) concat(Frame, RecB) init_timer(TAO)	Receiving
Receiving	octet_received_event & Index>MaxIndex	Phy_ABORT.ind(EP-4F) wait_time(TAO) FlagAbort=TRUE	*Received*
Receiving	collision_detected_event	stop_timer(TAO) Collision=TRUE init_timer(TAO)	Receiving
Receiving	time_out(TAO)	$none()	*Received*
Receiving	time_out(TARSO)	Phy_ABORT.ind(EP-5F) wait_time(TAO) FlagAbort=TRUE	*Received*
Receiving	Phy_ABORT.req()	Flagabort = TRUE	Receiving
Received	Service=NORMAL & not(Flagabort)	Phy_DATA.ind(Frame) init_timer(TOL)	M.Send
Received	(Service=NORMAL & Flagabort) | Service=UNACKNOWLEDGED	wait_time(TOL)	*T.Session*
Received	Service=ASO & Collision & not(Flagabort)	Phy_COLL.ind() Collision=FALSE	*T.RSO*
Received	Service=ASO & not(Collision) & not(Flagabort)	Phy_ASO.ind(Frame)	*T.RSO*
Received	Service=ASO & Flagabort	$none()	*T.RSO*
T.RSO	(TypeAG=AGT) | (WinRSO>=MaxRSO) & (TypeAG=AGN)	stop_timer(TARSO)	*T.Session*
T.RSO	(WinRSO<MaxRSO) & (TypeAG=AGN)	Index=1 Frame=""	W.RSO
W.RSO	time_out(TARSO)	WinRSO=WinRSO+1 init_timer(TARSO) init_timer(TA1O)	M.Rec
W.RSO	Phy_ABORT.req()	Flagabort=TRUE	W.RSO

Table 5 – Power supply management state transitions (only for non-energized Secondary Station)

Initial state	Triggering condition	Set of actions	Final state
Initial	alarm_detection()	Flagalarm = TRUE FlagSendAlarm =FALSE station_power(ON)	Stopped
Initial	not(alarm_detection())	Flagalarm = FALSE	Stopped
Stopped	occur(cpt_carrier_on) & Flagalarm	init_timer(TVASB)	W.TVASB2
Stopped	occur(data_carrier_on)	init_timer(TOSEUIL) init_timer(TAGT)	W.TOSEUIL
W.TOSEUIL	time_out(TOSEUIL)& not(Flagalarm)	station_power(ON)	W.AGT
W.TOSEUIL	occur(data_carrier_off) & not(Flagalarm)	stop_timer(TOSEUIL) stop_timer(TAGT)	Stopped
W.TOSEUIL	time_out(TOSEUIL) & Flagalarm	station_signal(ON) Tend = TOAG	W.AGT
W.TOSEUIL	occur(data_carrier_off) & Flagalarm	stop_timer(TOSEUIL) stop_timer(TAGT) Tend = TOAGN init_timer(Tend)	Hide
W.TOSEUIL	occur(cpt_carrier_on) & Flagalarm	init_timer(TVASB)	W.TVASB1
W.AGT	occur(data_carrier_off)	stop_timer(TAGT) init_timer(TOAPPEL)	W.Sel
W.AGT	time_out(TAGT) & not(Flagalarm)	station_power(OFF)	Stopped
W.AGT	time_out(TAGT) & Flagalarm	init_timer(Tend)	Hide
W.Sel	occur(octet_received_event)	stop_timer(TOAPPEL) init_timer(TOBAVARD) init_timer(TAO)	Select
W.Sel	time_out(TOAPPEL) & not(Flagalarm)	station_power(OFF)	Stopped
W.Sel	time_out(TOAPPEL) & Flagalarm	station_signal(OFF)	Stopped
W.Sel	occur(cpt_carrier_on) & Flagalarm & not(FlagSendalarm)	init_timer(TVASB)	W.TVASB1
Select	occur(octet_received_event)	stop_timer(TAO) init_timer(TAO)	Select
Select	time_out(TAO)	stop_timer(TOBAVARD) init_timer(TOPRE)	W.Answer
Select	time_out(TOBAVARD) & not(Flagalarm)	stop_timer(TAO) station_power(OFF)	Stopped
Select	time_out(TOBAVARD) & Flagalarm	stop_timer(TAO) init_timer(Tend)	Hide
W.Answer	occur(octet_sent_event)	stop_timer(TOPRE) init_timer(Tend)	Hide
W.Answer	time_out(TOPRE) & not(Flagalarm)	station_power(OFF)	Stopped
W.Answer	time_out(TOPRE) & Flagalarm	init_timer(Tend)	Hide
W.Answer	occur(cpt_carrier_on) & Flagalarm & not(FlagSendalarm)	init_timer(TVASB)	W.TVASB1
Hide	occur(octet_received_event) |occur(octet_sent_event) | (occur(data_carrier_on) & not(FlagSendAlarm))	stop_timer(Tend) init_timer(Tend)	Hide
Hide	occur(data_carrier_on) & FlagSendAlarm	stop_timer(Tend)	W.AGend
Hide	time_out(Tend) & not(Flagalarm)	station_power(OFF)	Stopped
Hide	time_out(Tend) & Flagalarm & not(FlagSendAlarm)	station_signal(OFF)	Stopped
Hide	time_out(Tend) & Flagalarm & FlagSendAlarm	Send_AG(AGN)	W.AB
Hide	occur(cpt_carrier_on) & Flagalarm & not(FlagSendalarm)	init_timer(TVASB)	W.TVASB1
W.AGend	occur(data_carrier_off)	wait_time(TOALR) Send_AG(AGN)	W.AB

Initial state	Triggering condition	Set of actions	Final state
W.TVASB1	occur(cpt_carrier_off)	stop_timer(TVASB) init_timer(Tend)	Hide
W.TVASB1	time_out(TVASB)	FlagSendAlarm = TRUE init_timer(Tend)	Hide
W.TVASB1	time_out(Tend)	$none()	W.TVASB2
W.TVASB2	occur(cpt_carrier_off)	stop_timer(TVASB) station_signal(OFF)	Stopped
W.TVASB2	occur(data_carrier_on)	$none()	W.TVASB1
W.TVASB2	time_out(TVASB)	Send_AG(AGN)	W.AB
W.AB	AG_sent_event	FlagSendAlarm = FALSE station_signal(OFF)	Stopped

Table 6 – *Physical-62056-3-1* state transitions: Secondary Station

Initial state	Triggering condition	Set of actions	Final state
Initial	energized()	MaxIndex=128 FlagRSO=FALSE FirstWinRSO=FALSE	Stopped
Initial	not(energized())	MaxIndex=18 FlagRSO=FALSE FirstWinRSO=TRUE	Stopped
Stopped	AG_received_event	Stop_timer(TOAG) init_timer(TA1O)	M.Rec
Stopped	Phy_ALARM.req()	TypeAG=ASB Send_AG(TypeAG)	W.ASB
Stopped	time_out(TOAG)	MaxIndex=18 FirstWinRSO=TRUE	Stopped
M.Rec	octet_received_event	Stop_timer(TA1O) Index=2 Frame="" Read_data(RecB) Concat(Frame, RecB) init_timer(TAO)	Receiving
M.Rec	time_out(TA1O)	Phy_ABORT(EP-1)	*WTOAG*
M.Rec	Phy_ABORT.req()	Stop_timer(TA1O)	*WTOAG*
Receiving	octet_received_event & Index<=MaxIndex	Stop_timer(TAO) Index=Index+1 Read_data(RecB) Concat(Frame, RecB) init_timer(TAO)	Receiving
Receiving	octet_received_event & Index>MaxIndex	Stop_timer(TAO) Phy_ABORT.ind(EP-4F)	*WTOAG*
Receiving	time_out(TAO)	Phy_DATA.ind(Frame) init_timer(TOL)	M.Send
Receiving	Phy_ABORT.req()	Stop_timer(TAO)	*WTOAG*
M.Send	Phy_DATA.req(Frame)	Stop_timer(TOL) MaxIndex=128 Size=size(Frame) Index=1 Send_octet(Frame, Index) Size=Size-1 init_timer(TOE)	Sending

Initial state	Triggering condition	Set of actions	Final state
M.Send	Phy_RSO.req(Frame, Window)	Stop_timer(TOL) MaxIndex=128 Wait_window(FirstWinRSO, Window) FirstWinRSO=FALSE Size=size(Frame) Index=1 Send_octet(Frame, Index) Size=Size-1 FlagRSO=TRUE init_timer(TOE)	Sending
M.Send	time_out(TOL)	init_timer(TA1O)	M.Rec
M.Send	Phy_ABORT.req()	Stop_timer(TOL)	*WTOAG*
Sending	octet_sent_event & Size>0	Index=Index+1 Send_octet(Frame, Index) Size=Size-1	Sending
Sending	octet_sent_event & Size=0 & not(FlagRSO)	Stop_timer(TOE) init_timer(TA1O)	M.Rec
Sending	octet_sent_event & Size=0 & FlagRSO	Stop_timer(TOE) Wait_time(TAO) FlagRSO=FALSE	WTOAG
Sending	Phy_ABORT.req()	Stop_timer(TOE)	WTOAG
Sending	time_out(TOE)	Phy_ABORT.ind(EP-3F)	WTOAG
W.ASB	time_out(TOAG)	MaxIndex=18 FirstWinRSO=TRUE	W.ASB
W.ASB	AG_sent_event	$none()	Stopped
WTOAG	not(energized)	init_timer(TOAG)	Stopped
WTOAG	Energized	$none()	Stopped

Table 7 – Meaning of the states listed in the previous tables

State	Meaning
Initial	Initialization of the variables of the layer
Stopped	Waiting state for a "Wakeup Call" signal
W.ETABS (Wait for end of "Alarm-Bus")	Waiting for the end of an "Alarm-bus" signal received in a Stopped state
W.AG (Wait for end of "Wakeup Call")	Waiting for the end of a "Wakeup Call" signal transmission
W.TAB (Wait "Alarm-Bus")	Waiting for an "Alarm-Bus" signal during delay at the end of transmission of a "Wakeup call" signal
W.ETAB (Wait for end of "Alarm-Bus")	Waiting for the end of an "Alarm-Bus" signal received after the transmission of a "Wakeup call" signal
W.TASB	Waiting for the triggering of wakeup TASB after the beginning of the reception of an "Alarm-Bus" signal
W.TOL	Waiting for the triggering of wakeup TOL
M.Send (Must Send)	Initial state of the transmitter waiting for a frame to send
T.Session	Testing the type of the session (with an energized or not energized Secondary Station)
SendFirst	Sending the first byte of the frame to be sent
Sending	Recurrent state of the transmitter transmitting one byte at a time
Answer	Branching depending on the service requested

State	Meaning
M.Rec (Must Receive)	Initial state of the receiver waiting for the first byte of a frame
Receiving	Recurrent state of the receiver receiving one byte at a time
Received	Processing the received frame depending on the service requested
T.RSO (Test last RSO)	Testing the end of the last time slot for RSO frame reception
W.RSO (Wait for end of an RSO time slot)	Waiting for the end of a time slot for RSO frame reception
W.ASB	Waiting for the end of a "Alarm Secondary-Bus" signal transmission
W.TOAG	Initializing the "end of session" TOAG timer if needed
W.TOSEUIL	Waiting for the triggering of wakeup TOSEUIL
W.AGT	Waiting for an AGT "Wakeup Call" signal
W.Sel (Wait for preSelection)	Waiting for a preselection frame
Select	Receiving a preselection frame
W.Answer	Waiting for an answer frame from a selected station
Hide	Waiting for the end of selection
W.AGend	Waiting for the end of AG reception
W.TVASB1	Waiting for the triggering of wakeup TVASB for an "Alarm Secondary-Bus" signal during a session
W.TVASB2	Waiting for the triggering of wakeup TVASB for an "Alarm Secondary-Bus" signal at the end of session
W.AB	Waiting for the end of a "Alarm Bus" signal transmission

Table 8 – Definition of the procedures, functions and events classified in alphabetical order

Procedure, function or event	Definition
AG_received_event	Event from the modem reporting that an AGN "Wakeup Call" signal has been correctly detected
AG_sent_event	Event from the modem reporting the end of the transmission of a "Wakeup Call" signal
alarm_detection()	Check that the station status of alarm mode is Active
collision_detected_event	Event from the modem reporting the detection of a framing error on reception of a byte
concat(Frame, RecB)	Concatenation of the byte RecB in the being built frame Frame
data_carrier_on, data_carrier_off	Occurrence of the detection on the bus of the data carrier on, the data carrier off
energized()	Check that the station is energized
init_timer(TOAPPEL), init_timer(TOSEUIL), init_timer(TAGT), init_timer(TOBAVARD), init_timer(TOPRE), init_timer(TOL), init_timer(TOE), init_timer(TAO), init_timer(TA1O), init_timer(TARSO) init_timer(TOAG), init_timer(TVASB) or init_timer(TAB)	setting of wakeup TOAPPEL, TOSEUIL, TAGT, TOBAVARD, TOPRE, TOL, TOE, TAO, TA1O, TARSO, TOAG, TVASB or TAB

Procedure, function or event	Definition
occur(cpt_carrier_on), occur(cpt_carrier_off), occur(data_carrier_on), occur(data_carrier_off), occur(octet_received_event) or occur(octet_sent_event)	Occurrence (reporting without consuming) of the detection on the secondary bus of the data carrier on, the data carrier off, on the bus of the data carrier on, the data carrier off, the reception of a byte or the emission of a byte
octet_received_event	Event from the modem reporting that a byte has been received
octet_sent_event	Event from the modem reporting that a byte has been sent
read_data(RecB)	Processing of the byte_received_event by reading the received RecB byte (bits are transmitted in ascending order)
send_AG(TypeAG)	Request to the modem for transmission of a "Wakeup Call" signal of duration TypeAG (AGN or AGT)
send_octet(Frame, Index)	Transmission of the byte of rank Index in the frame Frame (bits are transmitted in ascending order)
size(Frame)	Calculation of the number of bytes of the frame Frame
station_power(ON) or station_power(OFF)	Turning ON or OFF the energy supply to the device
station_signal(ON) or station_signal(OFF)	Turning ON or OFF the signal transmission to the device on the secondary bus
stop_timer(TOAPPEL), stop_timer(TOSEUIL), stop_timer(TAGT), stop_timer(TOBAVARD), stop_timer(TOPRE), stop_timer(TOL), stop_timer(TOE), stop_timer(TAO), stop_timer(TA1O), stop_timer(TVASB) or stop_timer(TAB)	Stopping of wakeup TOAPPEL, TOSEUIL, TAGT, TOBAVARD, TOPRE, TOL, TOE, TAO,TA1O, TVASB or TAB
stop_timer(TOAG) or stop_timer(TARSO)	Stopping of wakeup TOAG or TARSO only if it has previously been set
time_out(TOAPPEL), time_out(TOSEUIL), time_out(TAGT), time_out(TOBAVARD), time_out(TOPRE), time_out(TOL), time_out(TOE), time_out(TAO), time_out(TA1O), time_out(TARSO), time_out(TOAG), time_out(TVASB) or stop_timer(TAB)	Triggering of wakeup TOAPPEL, TOSEUIL, TAGT, TOBAVARD, TOPRE, TOL, TOE, TAO, TA1O, TARSO, TOAG, TVASB or TAB
wait_time(TAO), wait_time(TICB), wait_time(TOL) or wait_time(TOALR)	Calculated delay during time TAO, TICB, TOL or TOALR
wait_window(FirstWinRSO, Window)	Wait-time calculated as follows: when FirstWinRSO=TRUE or Window=0 ==> 0 ms when FirstWinRSO=FALSE and Window>0 ==> 40 ms + (TARSO*Window) ms (The 40 ms delay guarantees that the transmission has taken place in the time slot)

5.1.6 List and processing of errors

Errors are listed using the following codes:

EP = error in the *Physical* layer
– = separator
N = error number
F = fatal error

Errors related to *Physical 62056-3-1* are specified in Table 9.

Table 9 – Error summary table

EP-1	Expiry of TOL wakeup (Primary Station) before the *Data Link* layer requests a frame transmission or expiry of TA1O wakeup (Secondary Station) before any character has been received from the Primary station
	This error leads to the expectation of a "Wakeup Call" signal after having informed the *Data Link* layer
EP-2	Expiry of TOAG wakeup before any "Wakeup Call" signal
	This error leads to the expectation of a "Wakeup Call" signal after having informed the *Data Link* layer
EP-3	An alarm has been received
	This error leads to the reinitialization of the *Physical* layer after having informed the *Data Link* layer
EP-3F	Abnormal length of transmission detected after expiry of TOE wakeup
	This error leads to the reinitialization of the *Physical* layer after having informed the *Data Link* layer
EP-4F	Number of bytes received higher than MaxIndex (Transmitter too talkative)
	This error leads to the reinitialization of the *Physical* layer after having informed the *Data Link* layer
EP-5F	Expiry of TARSO wakeup while receiving an RSO frame (Primary Station only)
	This error leads to the reinitialization of the *Physical* layer after having informed the *Data Link* layer

If any of these errors occurs, it is sent up locally by means of the Phy_ABORT.ind service primitive. The complete list of fatal error numbers is given in Annex C.

5.2 Data Link layer

5.2.1 Link-62056-3-1 protocol

The *Link-62056-3-1* protocol of the *Data Link* layer of the local bus data exchange profile without DLMS behaves asymmetrically. The state machine of the Primary Station is therefore different from that of the Secondary Station.

The *Data Link* layer transforms the physical channel used by the *Physical* layer to a logic channel able to transmit reliable information. Its main functions are:

- to carry out a serialization and a deserialization of the data (if the physical channel functions serially one bit at a time);
- to synchronize the transmission and reception frames;
- to filter the frames according to primary and secondary addresses;
- to ensure efficient protection against transmission errors.

5.2.2 Management of exchanges

On the Primary station, the *Link-62056-3-1* protocol takes over the transmission of an AGN or AGT "Wakeup Call" signal according to the type of Secondary Station. Detection of incompatibility in the addresses of a DSDU received from the upper layer indicates a fatal error and the stop of the *Link-62056-3-1* protocol.

On the Secondary Station, reception of an incorrect frame does not require any processing, as recovering is left to the Primary Station.

For non-energized stations, the detection of a "Forgotten Stations Call" after an AGT "Wakeup Call" signal leads to an RSO response which always takes place in the first RSO time slot. Thus, the Primary Station, when detecting a collision after such a sequence, performs a second "Forgotten Stations Call", but this time after an AGN "Wakeup Call" signal. Nevertheless, when no collision is detected after the first call, there is one or no forgotten station and no need for a second call.

5.2.3 Data Link services and service primitives

The user of the *Link-62056-3-1* protocol can use the services and service primitives given in Table 10.

Table 10 – Data Link services and service primitives

Service	Service primitive
DL_DATA	DL_DATA.req(DSDU) DL_DATA.ind(DSDU)
DL_ALARM	DL_ALARM.req() DL_ALARM.ind()
DL_ABORT	DL_ABORT.req() DL_ABORT.ind(ErrorNb)

The role assigned to each primitive is as follows:

- DL_DATA.req(DSDU) enables the *Application* layer to request the *Data Link* layer to transfer a DSDU data packet;
- DL_DATA.ind(DSDU) enables the *Data Link* layer to inform the *Application* layer of the arrival of a DSDU data packet;
- DL_ALARM.req() enables the *Application* layer to request the *Data Link* layer to transfer an alarm;
- DL_ALARM.ind() enables the *Data Link* layer to inform the *Application* layer of the arrival of an alarm;
- DL_ABORT.req() enables the *Application* layer to request the *Data Link* layer to end its activity;
- DL_ABORT.ind (ErrorNb) enables the *Data Link* layer to inform the *Application* layer of the occurrence of a fatal error identified by the number ErrorNb.

5.2.4 Data Link parameters

For the Primary Station, the value of the number of repeat transmissions for a given frame before disconnection, MaxRetry, is set to 2.

The value of the number of sequences linked with no "Wakeup Call" signal for remote reading and remote transfer, MaxChain, is set to 5, for compatibility with Secondary Stations using a previous version of the protocol.

The value of the maximum number, MaxRSO, of RSO time slots for the processing of a "Forgotten Stations Call" is set to 3 after an AGN "Wakeup Call" signal, at 1 after an AGT "Wakeup Call" signal.

The Secondary Station shall know the list of Primary Station addresses and the list of TABi to which it has been programmed.

The station may also be solicited by the general primary address APG. In this case, it replies with the first primary address to which it has been programmed.

5.2.5 State transitions

Link-62056-3-1 state transitions are as specified in Table 11, Table 12, Table 13 and Table 14.

Table 11 – *Link-62056-3-1* state transitions: Primary Station

Initial state	Triggering condition	Set of actions	Final state
Initial	$true()	MaxRetry=2 MaxChain=5	Stopped
Stopped	DL_DATA.req(DSDU) & check_req(DSDU)	NbChain=0 MaxRSO=3 PreSel=FALSE NoRetry=FALSE RepeatASO=FALSE EP-1=FALSE context(ADS, ADP, TypeAG) Com=command(DSDU) init(Com, TypeAG) Phy_APPG.req(TypeAG)	W.AG
Stopped	DL_DATA.req(DSDU) & not(check_req(DSDU))	DL_ABORT.ind(EL-1F)	Stopped
Stopped	Phy_ALARM.ind()	DL_ALARM.ind()	Stopped
W.AG	Phy_APPG.ind() & not(PreSel) & not(NoRetry) & not(RepeatASO)	$none()	*T.Req*
W.AG	Phy_APPG.ind() & PreSel	Index=MaxRetry+1 Fr=PRE Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
W.AG	Phy_APPG.ind() & NoRetry	Index=MaxRetry+1 Fr=DSDU Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) NbChain=1 Phy_DATA.req(Fr) NoRetry=FALSE	M.Rec
W.AG	Phy_APPG.ind() & RepeatASO	RepeatASO=FALSE Phy_ASO.req(Fr)	M.RSO
W.AG	DL_ABORT.req()	Phy_ABORT.req()	W.EndS
W.EndS	Phy_ABORT.ind(ErrorNb)	$none()	*T.Error*
W.EndS	Phy_ALARM.ind()	DL_ALARM.ind()	Stopped
T.Error	((Error_Nb = EP-1 & TypeAG = AGN) I (Error_Nb = EP-2 & TypeAG = AGT)) & Com <>IB & Com <> TRB	$none()	Stopped
T.Error	((Error_Nb = EP-1 & TypeAG = AGN) I (Error_Nb = EP-2 & TypeAG = AGT)) & (Com=IB | Com=TRB)	DL_ABORT.ind(Error_Nb)	Stopped

Initial state	Triggering condition	Set of actions	Final state
T.Error	Error_Nb <> EP-1 & Error_Nb <> EP-2	DL_ABORT.ind(Error_Nb)	W.EndS
T.Error	(Error_Nb = EP-1) & TypeAG = AGT	$none()	W.EndS
T.Req	Com=IB | Com=TRB	Fr=DSDU Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_UNACK.req(Fr)	W.EndS
T.Req	Com=ASO & TypeAG=AGN	MaxRSO=3 NbRSO=1 ListRSO="" Collision=FALSE Fr=DSDU Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_ASO.req(Fr)	M.RSO
T.Req	Com=ASO & TypeAG=AGT	MaxRSO=1 NbRSO=1 ListRSO="" Collision=FALSE Fr=DSDU Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_ASO.req(Fr)	M.RSO
T.Req	((NbChain<MaxChain) & (Com=ENQ | Com=TRF)) | (NbChain=0 & Com=REC)	Fr=DSDU Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Index=1 NbChain=NbChain+1 Phy_DATA.req(Fr)	M.Rec
T.Req	Com=AUT	Fr=DSDU Fr=concat(size_frame(Fr),ADS,ADP,Fr) Fr=concat(Fr, crc(Fr)) Index=1 NbChain=MaxChain Phy_DATA.req(Fr)	M.Rec
T.Req	(NbChain>=MaxChain) | (NbChain<>0 & Com=REC)	NbChain=0 Phy_APPG.req(AGN)	W.AG
M.Rec	Phy_DATA.ind(Frame) & check_frame(Frame) & not(PreSel)	DSDU=extract_DSDU(Frame) DL_DATA.ind(DSDU)	M.Send
M.Rec	Phy_DATA.ind(Frame) & check_frame(Frame) & command(Frame)=SEL & PreSel	PreSel=FALSE	*T.Req*
M.Rec	Phy_DATA.ind(Frame) & check_frame(Frame) & command(Frame)<>SEL & PreSel	Phy_ABORT.req() DL_ABORT.ind(EL-2F)	W.EndS
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame)) & Index<=MaxRetry	Index=Index+1 Phy_DATA.req(Fr)	M.Rec
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame)) & Index>MaxRetry	Phy_ABORT.req() DL_ABORT.ind(EL-2F)	W.EndS
M.Rec	DL_ABORT.req()	Phy_ABORT.req()	W.EndS
M.Rec	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	W.EndS
M.RSO	Phy_ASO.ind(Frame) & size(Frame)=0	$none()	*T.RSO*
M.RSO	Phy_ASO.ind(Frame) & size(Frame)<>0 & check_frame(Frame) & command(Frame)=RSO	build_RSO(ListRSO, Frame)	*T.RSO*
M.RSO	Phy_ASO.ind(Frame) & size(Frame)<>0 & not(check_frame(Frame))	Collision=TRUE	*T.RSO*

Initial state	Triggering condition	Set of actions	Final state
M.RSO	Phy_COLL.ind()	Collision=TRUE	*T.RSO*
M.RSO	DL_ABORT.req()	Phy_ABORT.req()	W.EndS
M.RSO	Phy_ABORT.int(ErrorNb)	DL_ABORT.ind(ErrorNb)	W.EndS
T.RSO	MaxRSO=1 & Collision	MaxRSO=3 Collision=FALSE RepeatASO=TRUE Phy_APPG.req(AGN)	W.AG
T.RSO	(MaxRSO=1 & not(Collision)) | (MaxRSO<>1 & NbRSO>=MaxRSO)	DSDU=rso(RSO, Collision, ListRSO) DL_DATA.ind(DSDU)	W.EndS
T.RSO	NbRSO<MaxRSO	NbRSO=NbRSO+1	M.RSO
M.Send	DL_DATA.req(DSDU) & check_req(DSDU) & not(EP-1)	Com=command(DSDU)	*T.Req*
M.Send	DL_DATA.req(DSDU) & check_req(DSDU) & EP-1	Com=command(DSDU) NbChain=0 EP-1=FALSE Phy_APPG.req(AGN)	W.AG
M.Send	DL_DATA.req(DSDU) & not(check_req(DSDU))	Phy_ABORT.req() DL_ABORT.ind(FL-1F)	W.EndS
M.Send	Phy_ABORT.ind(EP-1)	EP-1=TRUE	M.Send
M.Send	Phy_ABORT.ind(EP-2)	$none()	Stopped
M.Send	DL_ABORT.req() & not(EP_1 & TypAG=AGN)	Phy_ABORT.req()	W.EndS
M.Send	DL_ABORT.req() & EP_1 & TypAG=AGN	$none()	Stopped
M.Send	Phy_ABORT.ind(ErrorNb) & ErrorNb<>EP-1 & ErrorNb<>EP-2	DL_ABORT.ind(ErrorNb)	W.EndS

Table 12 – *Link-62056-3-1* State transitions: Secondary Station

Initial state	Triggering condition	Set of actions	Final state
Initial	$true()	FlagDSO=TRUE Discovered=FALSE Flag_alarm = FALSE	Stopped
Stopped	Phy_DATA.ind(Frame) & check_frame(Frame) & check_address(Frame)	ADP=extract_ADP(Frame) Com=command(Frame)	*T.Com*
Stopped	Phy_DATA.ind(Frame) & check_frame(Frame) & not(check_address(Frame))	Phy_ABORT.req()	Stopped
Stopped	Phy_DATA.ind(Frame) & not(check_frame(Frame))	$none()	Stopped
Stopped	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	Stopped
Stopped	DL_ALARM.req()	Phy_ALARM.req() Flag_alarm = TRUE	Stopped
T.Com	Com=IB	FlagDSO=TRUE Discovered=FALSE Phy_ABORT.req()	Stopped
T.Com	Com=TRB	DSDU=extract_DSDU(Frame) DL_DATA.ind(DSDU) Phy_ABORT.req()	Stopped
T.Com	Com=PRE	Fr=SEL Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	Stopped
T.Com	Com=ASO & test_TABi(Frame, TAB)	Fr=concat(RSO, TAB, ADS) Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_RSO.req(Fr, window_RSO())	Stopped
T.Com	Com=ASO & not(test_TABi(Frame, TAB))	Phy_ABORT.req()	Stopped
T.Com	Com=ENQ | Com=REC | Com=TRF | COM=AUT	DSDU=extract_DSDU(Frame) DL_DATA.ind(DSDU)	M.Send
M.Send	DL_DATA.req(DSDU)	Fr=DSDU Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) update_flag_DSO(command(Fr))	Stopped
M.Send	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	Stopped

Table 13 – Meaning of the states listed in the previous tables

State	Meaning
Initial	Initialization of the variables of the layer
Stopped	Waiting state for the first request from the upper layer or the first indication from the lower layer
W.AG (Wait for end of "Wakeup Call")	Waiting for the end of a requested "Wakeup Call" signal
W.EndS (Wait for End of Session)	Waiting for the end of the session
T.Req (Test Request)	Test the nature of a request from the upper layer
M.Rec (Must Receive)	Waiting state for an indication from the lower layer
M.RSO (Must receive RSO)	Waiting for an RSO frame following an ASO frame sent
T.RSO (Test last RSO)	Testing the end of the last time slot for RSO frame reception
M.Send (Must Send)	Waiting state for a request from the upper layer
T.Com (Test Command)	Test of the command code of a received frame

Table 14 – Definition of the procedures and functions classified in alphabetical order

Procedure or function	Definition
build_RSO(ListRSO, Frame)	Extraction of the RSO elements (TAB and ADS fields) from the received RSO frame Frame and concatenation with the preceding list ListRSO
check_address(Frame)	Check that the ADP and ADS addresses are recognized according to the following criteria: – ADP is APG or the station has been programmed to the ADP address; – if the command code is ASO, IB or TRB, then ADS is ADG; – if the command code is not ASO, IB nor TRB, then ADS is the secondary station address
check_frame(Frame)	Check that the frame Frame received is correct: – number of bytes greater than or equal to 11 and lower than or equal to 128; – CRC correct; – number of bytes compatible with the field N; – command code recognized and number of bytes compatible with the command code
check_req(DSDU)	Check that the requested command code inside a DSDU is compatible with ADP and ADS addresses defined in the communication context
command(DSDU) or command(Frame)	Extraction of the value of the command code of a DSDU to send or a received frame Frame
concat(N, ADS, ADP, DSDU) or concat(Frame, CRC)	Concatenation of the fields N, ADS and ADP with the DSDU or concatenation of the CRC at the end of the frame Frame
context(ADS, ADP, TypeAG)	Extraction of the corresponding values from the communication context
crc(Frame)	Calculation of the CRC of the frame Frame to send
extract_ADP(Frame)	If either the ADP value used in the frame is not APG or if it is the APG value but the list of the ADP values to which the Secondary Station has been programmed is empty, then extraction of this value, otherwise extraction of the first ADP value to which the Secondary Station has been programmed

Procedure or function	Definition
extract_DSDU(Frame)	Extraction of the DSDU (COM and DATA fields) from the frame Frame received
init(COM, TypeAG)	Set PreSel to TRUE if both TypeAG equals AGT and the size of the frame is greater than 18 bytes. Set NoRetry to TRUE if both TypeAG equals AGT and the size of the frame is lower than or equal to 18 bytes.
rso(RSO, Collision, ListRSO)	Concatenation of the RSO command code, the collision indicator and the list of the RSO elements (TAB and ADS fields)
size(Frame)	Calculation of the size of the frame Frame received
size_frame(DSDU)	Calculation of the size of the frame associated with a DSDU to be sent (size(DSDU) + 10)
test_TABi(Frame, TAB)	If the first TABi contained in the received ASO frame Frame equals 00, check that Discovered=FALSE then, after provision of a whole random integer between 0 and 100, check that this integer is smaller than the response probability (second TABi). In this case, 00 is memorized in the TAB variable; If the first TABi contained in the received ASO frame Frame equals FF, check that Flag_alarm=TRUE then, in this case, Flag_alarm is set to FALSE and FF is memorized in the TAB variable; If the first TABi contained in the received ASO frame Frame does not equal 00 or FF, check that FlagDSO=TRUE and check that the Secondary Station has been programmed to one of the TABi contained in the received ASO frame Frame. In this case, the first of these values is memorized in the TAB variable
update_flag_DSO(COM)	Set FlagDSO to FALSE and Discovered to TRUE if COM equals ENQ
window_RSO()	Provision of a whole random integer between 0 and MaxRSO-1 used as the number of the RSO time slot in which the station shall reply (refer to Annex F)

5.2.6 List and processing of errors

Errors are listed using the following codes:

EL = error in the *Data Link* layer
– = separator
N = error number
F = fatal error

Errors related to *Link-62056-3-1* are specified in Table 15.

Table 15 – Error summary table

EL-1F	Reception of a command code not compatible with the ADP and ADS addresses memorized in the communication context (Primary Station only)
	This error leads to the reinitialization of the *Data Link* layer after having informed the *Application* layer
EL-2F	Incorrect response from the Secondary Station after either a non-energized station preselection frame or MaxRetry repeated transmissions of a request (Primary Station only)
	This error leads to the re-initialization of the *Data Link* layer after having informed the *Application* layer

If any of these errors occurs, it is sent up locally by means of the DL_ABORT.ind service primitive. The complete list of fatal error numbers is given in Annex C.

5.3 Application layer

5.3.1 Application-62056-3-1 protocol

The *Application-62056-3-1* protocol of the *Application* layer of the local bus data exchange profile without DLMS behaves asymmetrically. The state machine of the Primary Station is therefore different from that of the Secondary Station.

The *Application-62056-3-1* protocol of the *Application* layer of the local bus data exchange profile without DLMS controls and links successive messages by analysing the command code supplied by the user application.

5.3.2 Application services and service primitives

The user of the *Application-62056-3-1* protocol can use the services and service primitives given in Table 16.

Table 16 – Application services and service primitives

Service	Service primitive
A_DATA	A_DATA.req(COM, ASDU) A_DATA.ind(ASDU)
A_ALARM	A_ALARM.req() A_ALARM.ind()
A_ABORT	A_ABORT.req() A_ABORT.ind(ErrorNb)

The role assigned to each primitive is as follows:

- A_DATA.req(COM, ASDU) enables the application to request the *Application* layer to transfer a COM (ENQ, REC, TRF, TRB, IB or ASO for a Primary Station and DAT, DRJ, EOS or TRA for a Secondary Station) command code linked with an ASDU information unit;
- A_DATA.ind(ASDU) enables the *Application* layer to inform the application of the arrival of an ASDU information unit;
- A_ALARM.req()enables the application to request the *Application* layer to send an alarm;
- A_ALARM.ind() enables the *Application* layer to inform the application of the arrival of an alarm;
- A_ABORT.req() enables the application to request the *Application* layer to end its activity;
- A_ABORT.ind(ErrorNb) enables the *Application* layer to inform the application of the occurrence of a fatal error identified by the number ErrorNb.

5.3.3 Application parameters

The Primary Station shall know the DES ciphering keys of all Secondary Stations for which a remote programming is to be carried out.

In case of remote programming, the Secondary Station shall know the DES ciphering key that could be used by the Primary Station.

5.3.4 State transitions

Application-62056-3-1 state transitions are as specified in Table 17, Table 18, Table 19 and Table 20.

Table 17 – *Application-62056-3-1* state transitions: Primary Station

Initial state	Triggering condition	Set of actions	Final state
Stopped	A_DATA.req(Com, ASDU) & (Com=ASO | Com=ENQ | Com=TRF)	APDU=concat(Com, _, _, ASDU) DL_DATA.req(APDU)	M.Rec
Stopped	A_DATA.req(Com, ASDU) & (Com=IB | Com=TRB)	APDU=concat(Com, _, _, ASDU) DL_DATA.req(APDU)	W.EndS
Stopped	A_DATA.req(Com, ASDU) & Com=REC	Na1=randomize() Zdt=zdt(ASDU) APDU=concat(REC, Na1, 0, Zdt) DL_DATA.req(APDU) Na1k=cipher(Na1)	M.Rec
Stopped	DL_ALARM.ind()	A_ALARM.ind()	Stopped
Stopped	A_ABORT.req()	DL_ABORT.req()	Stopped
M.Rec	DL_DATA.ind(DSDU)	Resp=command(DSDU)	*T.Resp*
M.Rec	A_ABORT.req()	DL_ABORT.req()	Stopped
M.Rec	DL_ABORT.ind(ErrorNb) & Error_Nb <> EP_1 & Error_Nb <> EP_2	A_ABORT.ind(ErrorNb)	Stopped
M.Rec	DL_ABORT.ind(ErrorNb) & (Error_Nb = EP_1 I Error_Nb = EP_2)	$none()	M.Rec
W.EndS	DL_ABORT.ind(ErrorNb)	A_ABORT.ind(ErrorNb)	Stopped
W.EndS	A_ABORT.req()	DL_ABORT.req()	W.EndS
T.Resp	(Com=ASO & Resp=RSO) | (Com=ENQ & Resp=DAT) | (Com=ENQ & Resp=DRJ) | (Com=TRF & Resp=TRA) | (Com=TRF & Resp=DRJ) | (Com=AUT & Resp=EOS) | (Com=AUT & Resp=DRJ)	A_DATA.ind(DSDU)	Stopped
T.Resp	Com=REC & Resp=ECH & na1k(DSDU)=Na1k & Zdt=zdt(DSDU)	Na2=na2(DSDU) Na2k=cipher(Na2) Com=AUT APDU=concat(AUT, 0, Na2k, ‘’’’) DL_DATA.req(APDU)	M.Rec
T.Resp	(Com=ASO & Resp<>RSO) | (Com=ENQ & Resp<>DAT & Resp<>DRJ) | (Com=TRF & Resp<>TRA & Resp<>DRJ) | (Com=REC & Resp<>ECH) | (Com=AUT & Resp<>ARJ & Resp<>DRJ & Resp<>EOS)	A_ABORT.ind(EA-1F) DL_ABORT.req()	Stopped
T.Resp	Com=REC & (Resp<>ECH | (na1k(DSDU)<>Na1k) | (Zdt<>zdt(DSDU))	A_ABORT.ind(EA-2F) DL_ABORT.req()	Stopped
T.Resp	Com=AUT & Resp=ARJ	A_ABORT.ind(EA-3F) DL_ABORT.req()	Stopped

Table 18 – *Application-62056-3-1* state transitions: Secondary Station

Initial state	Triggering condition	Set of actions	Final state
Stopped	DL_DATA.ind(DSDU) & (command(DSDU)=ENQ | command(DSDU)=TRF)	A_DATA.ind(DSDU) Req=command(DSDU)	M.Send
Stopped	DL_DATA.ind(DSDU) & command(DSDU)=TRB	A_DATA.ind(DSDU)	Stopped
Stopped	DL_DATA.ind(DSDU) & command(DSDU)=REC	Zdt=zdt(DSDU) Na1=na1(DSDU) Na1k=cipher(Na1) Na2=randomize() APDU=concat(ECH, Na1k, Na2, Zdt) DL_DATA.req(APDU) Na2k=cipher(Na2) Req=REC	W.AUT
Stopped	A_ALARM.req() & alarm_detection()	DL_ALARM.req()	Stopped
M.Send	A_DATA.req(COM, ASDU) & (((COM=DAT | COM=DRJ) & Req=ENQ) | ((COM=TRA | COM=DRJ) & Req=TRF) | (COM=DRJ & Req=REC))	APDU=concat(COM, _, _, ASDU) DL_DATA.req(APDU)	Stopped
M.Send	A_DATA.req(COM, ASDU) & (COM=EOS & Req=REC)	APDU=concat(EOS, 0, 0, ‘’’’) DL_DATA.req(APDU)	Stopped
M.Send	DL_ABORT.ind(ErrorNb)	A_ABORT.ind(ErrorNb)	Stopped
W.AUT	DL_DATA.ind(DSDU) & command(DSDU)=AUT & na2k(DSDU)=Na2k	ASDU=concat(REC, _, _, Zdt) A_DATA.ind(ASDU)	M.Send
W.AUT	DL_DATA.ind(DSDU) & command(DSDU)=AUT & na2k(DSDU)<>Na2k	APDU=concat(ARJ, _, _, ‘’’’) DL_DATA.req(APDU)	Stopped
W.AUT	DL_ABORT.ind(ErrorNb)	A_ABORT.ind(ErrorNb)	Stopped

Table 19 – Meaning of the states listed in the previous tables

State	Meaning
Stopped	Waiting state for the first request from the upper layer or the first indication from the lower layer
M.Rec (Must Receive)	Standby for the response to the request transmitted
T.Resp (Test Response)	Processing of the response received
M.Send (Must Send)	Waiting for a response to a received request
W.AUT (Wait for AUT frame)	Waiting for an AUT frame following an ECH response frame sent

Table 20 – Definition of the procedures and functions classified in alphabetical order

Procedure or function	Definition
alarm_detection()	Check that the status of Alarm mode is Active
cipher(Na1) or cipher(Na2)	Ciphering of random number Na1 or Na2 by means of DES algorithm with key contained in the communication context
command(DSDU)	Extraction of the value of the command code of a received DSDU
concat(COM, _, _, ASDU), concat(COM, ZA1, ZA2, ZDT) or concat(COM, 0, 0, _)	Concatenation of a COM command code and an ASDU or concatenation of a COM command code with an encrypted value ZA1, an encrypted value ZA2 and a data field ZDT (TAB and DATA fields) or concatenation of a COM command code and the ZA1 = 0 and ZA2 = 0 fields
na1(DSDU)	Extraction of the Na1 value from the ZA1 field of a received REC frame
na1k(DSDU)	Extraction of the Na1k value from the ZA1 field of a received ECH frame
na2(DSDU)	Extraction of the Na2 value from the ZA2 field of a received ECH frame
na2k(DSDU)	Extraction of the Na2k value from the ZA2 field of a received AUT frame
randomize()	Generation of a random number according to the procedure described in Annex G
zdt(ASDU) or zdt(DSDU)	Extraction of data (TAB and DATA fields) from a REC request, a REC frame or an ECH frame

5.3.5 List and processing of errors

Errors are listed using the following codes:

EA = error in the *Application* layer
– = separator
N = error number
F = fatal error

Errors related to *Link-62056-3-1* are specified in Table 21.

Table 21 – Error summary table

EA-1F	The response command code of the received frame does not correspond with the request command code (Primary Station only)
	This error leads to the re-initialization of the *Application* layer after having informed the application
EA-2F	The Secondary Station has not been correctly authenticated (Primary Station only)
	This error leads to the re-initialization of the *Application* layer after having informed the application
EA-3F	The Primary Station has not been correctly authenticated (Primary Station only)
	This error leads to the re-initialization of the *Application* layer after having informed the application

If any of these errors occurs, it is sent up locally by means of the A_ABORT.ind service primitive. The complete list of fatal error numbers is given in Annex C.

6 Local bus data exchange with DLMS

6.1 Physical layer

The *Physical-62056-3-1* protocol of the *Physical* layer of the local bus data exchange profile with DLMS is exactly the same as the one defined for the profile without DLMS.

6.2 Data Link layer

6.2.1 Link-E/D protocol

The *Link-E/D* protocol of the *Data Link* layer of the local bus data exchange profile with DLMS behaves asymmetrically. The state machine of the Primary Station is therefore different from that of the Secondary Station.

The *Data Link* layer transforms the physical channel used by the *Physical* layer into a logic channel able to transmit reliable information. Its main functions are:

- to manage directly the Bus Initialization and Forgotten Stations Call services;
- to carry out serialization and deserialization of the data (if the physical channel functions serially one bit at a time);
- to synchronize the transmission and reception of the frames;
- to filter the frames according to primary and secondary addresses;
- to ensure efficient protection against transmission errors.

6.2.2 Management of exchanges

Bus Initialization, Alarm and Forgotten Stations Call services are provided by the *Link E/D* protocol of the *Data Link* layer of the local bus data exchange profile with DLMS, but their operation takes place outside the *Application* layer. In particular, the forgotten station flag can be updated by the Application Programming Interface when a remote reading exchange occurs.

Except during opening of the communication session and Bus Initialization, Alarm report or management of Forgotten Stations Call, the protocol is perfectly symmetrical, and both stations take turns to act as Transmitter and Receiver.

After sending a frame, the *Data Link* layer of the Transmitter end always waits for a frame from the *Data Link* layer of the Receiver before transmitting again. This wait is controlled by the T1 wakeup, whose duration is 10 s.

After sending a frame and receiving an acknowledgement of the previously sent one, the current frame is retransmitted. The number of repeat transmissions is limited to MaxRetry. Above this number, the communication is stopped at the *Data Link* level and the *Application* layer is informed.

Each time a frame is received by one of the systems, an answer frame is immediately transmitted. This transmitted frame may contain data from the *Application* layer. It always contains a *Send* number and a *Confirm* number calculated according to the values of those previously sent and received. The following algorithm is used to calculate these numbers:

- if the last frame received is error-free and its *Send* number is equal to the 1's complement of the previous *Confirm* number in transmission, then the data packet is transmitted to the *Application* layer and the next frame sent will have a *Confirm* number equal to the received *Send* number. If not, the *Confirm* number is not modified and the data packet is not transmitted to the *Application* layer;
- if the last frame received is error-free and its *Confirm* number is identical to the previous *Send* number in transmission, then the *Send* number in transmission is made up to 1 for the next frame on the assumption that a new data packet has to be sent;
- if the last frame received is incorrect or if its *Confirm* number is not identical to the previous *Send* number in transmission, then the same frame is transmitted again, on condition that the number of repeat transmissions remains less than or equal to MaxRetry.

6.2.3 Data Link services and service primitives

The user of the *Link-E/D* protocol can use the services and service primitives given in Table 22.

Table 22 – Data Link services and service primitives

Service	Service primitive
DL_DATA	DL_DATA.req(Pr, DSDU) DL_DATA.ind(Pr, DSDU)
DL_IB	DL_IB.req()
DL_ASO	DL_ASO.req(DSDU) DL_ASO.ind(Collision, List)
DL_ALARM	DL_ALARM.req()
DL_ABORT	DL_ABORT.req(Strong) DL_ABORT.ind(ErrorNb)

The role assigned to each primitive is as follows:

- DL_DATA.req(Pr, DSDU) enables the *Application* layer to request the *Data Link* layer to transfer a DSDU data packet with the priority Pr [3];
- DL_DATA.ind(Pr, DSDU) enables the *Data Link* layer to inform the *Application* layer of the arrival of a DSDU data packet with the priority Pr;
- DL_IB.req() enables the *Support Manager* to request the *Data Link* layer to send a Bus Initialization frame;
- DL_ASO.req(DSDU) enables the *Support Manager* to request the *Data Link* layer to send a Forgotten Stations Call frame in accordance with a DSDU data packet;
- DL_ASO.ind(Collision, List) enables the *Data Link* layer to inform the *Application Programming Interface* of the result of a Forgotten Stations Call;
- DL_ALARM.req() enables the *Support Manager* to request the *Data Link* layer to transfer an alarm;
- DL_ABORT.req(Strong) enables the *Application* layer to request the *Data Link* layer to terminate its activity with the priority Strong [4];
- DL_ABORT.ind(ErrorNb) enables the *Data Link* layer to inform the *Application* layer of the occurrence of a fatal error identified by the number ErrorNb.

6.2.4 Data Link parameters

The value of the number of repeat transmissions for a given frame before disconnection, MaxRetry, is set to 2.

For the Primary Station, the value of the maximum number, MaxRSO, of RSO time slots for the processing of a "Forgotten Stations Call" is set to 3.

The Secondary Station shall know the list of Primary Station addresses and the list of TABi to which it has been programmed.

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[3] The priority level Pr differentiates the processing of emergency services such as InformationReport (level Pr=1) from that of the other DLMS services (level Pr=0).

[4] The Strong parameter differentiates the processing of fatal errors (Strong=1) from that of the other physical disconnection requests (Strong=0) initialized by the *Application* sub-layer.

The station may also be solicited by the general primary address APG. In this case, it replies with the first primary address to which it has been programmed.

6.2.5 State transitions

Link-E/D state transitions are as specified in Table 23, Table 24, Table 25 and Table 26.

Table 23 – *Link-E/D* state transitions: Primary Station

Initial state	Triggering condition	Set of actions	Final state
Initial	$true()	MaxRetry=2 MaxChain = 5 init_incrChain()	Stopped
Stopped	exist_dl_req()	NbChain = 0 RepeatASO=FALSE context(ADP, ADS, TypeAG) init(TypeAG) Phy_APPG.req(TypeAG)	W.AG
Stopped	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	Stopped
Stopped	Phy_ALARM.ind()	create_alarm(TPDU) DL_DATA.ind(Pr = 1, TPDU)	Stopped
W.AG	Phy_APPG.ind() & not(RepeatASO) & NbChain = 0	$none()	*T.Req*
W.AG	Phy_APPG.ind() & not(RepeatASO) & NbChain <> 0	NbChain = 0	*M.Send*
W.AG	Phy_APPG.ind() & RepeatASO	RepeatASO=FALSE Phy_ASO.req(Fr)	M.RSO
W.AG	DL_ABORT.req(_)	Phy_ABORT.req()	W.EndS
W.EndS	(Phy_ABORT.ind(EP-2) & TypeAG=AGT) I (Phy_ABORT.ind(EP-1) & TypeAG=AGN)	$none()	Stopped
W.EndS	Phy_ALARM.ind	create_alarm(TPDU) DL_DATA.ind(Pr = 1, TPDU)	Stopped
W.EndS	Phy_ABORT.ind(ErrorNb) & ErrorNb<>EP-1 & ErrorNb<>EP-2	DL_ABORT.ind(ErrorNb)	W.EndS
T.Req	exist_dl_req(DL_IB.req())	Fr="" Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, IB, Fr) Fr=concat(Fr, crc(Fr)) Phy_UNACK.req(Fr)	W.EndS
T.Req	exist_dl_req(DL_ASO.req(DSDU)) & TypeAG=AGN	MaxRSO=3 NbRSO=1 ListRSO="" Collision=FALSE Fr=DSDU Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, ASO, Fr) Fr=concat(Fr, crc(Fr)) Phy_ASO.req(Fr)	M.RSO
T.Req	exist_dl_req(DL_ASO.req(DSDU)) & TypeAG=AGT	MaxRSO=1 NbRSO=1 ListRSO="" Collision=FALSE Fr=DSDU Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, ASO, Fr) Fr=concat(Fr, crc(Fr)) Phy_ASO.req(Fr)	M.RSO

Initial state	Triggering condition	Set of actions	Final state
T.Req	not (exist_dl_req(DL_IB.req()) | exist_dl_req(DL_ASO.req(_)))	Pr=0 Send="00"B Confirm="11"B Fr="" Index=Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.RSO	Phy_ASO.ind(Frame) & size(Frame)=0	$none()	*T.RSO*
M.RSO	Phy_ASO.ind(Frame) & check_frame(Frame) & command(Frame)=RSO	build_RSO(ListRSO, Frame)	*T.RSO*
M.RSO	Phy_ASO.ind(Frame) & not(check_frame(Frame)) & size(Frame)<>0	Collision=TRUE	*T.RSO*
M.RSO	Phy_COLL.ind()	Collision=TRUE	*T.RSO*
M.RSO	DL_ABORT.req(_)	Phy_ABORT.req()	W.EndS
M.RSO	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	W.EndS
T.RSO	MaxRSO=1 & Collision	MaxRSO=3 Collision=FALSE RepeatASO=TRUE Phy_APPG.req(AGN)	W.AG
T.RSO	(MaxRSO=1 & not(Collision)) | (MaxRSO<>1 & NbRSO>=MaxRSO)	DL_ASO.ind(Collision, ListRSO)	W.EndS
T.RSO	NbRSO<MaxRSO	NbRSO=NbRSO+1	M.RSO
M.Send	exist_dl_data_req(DL_DATA.req(Pr=1, DSDU)) & NbChain < MaxChain	Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index= Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.Send	not(DL_DATA.req(Pr=1, _)) & exist_dl_data_req(DL_DATA.req(Pr=0, DSDU)) & NbChain < MaxChain	Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index= Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.Send	not(DL_DATA.req(_, _)) & NbChain < MaxChain	Pr=0 Fr="" Index= Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.Send	NbChain >= MaxChain	Phy_APPG.req(AGN)	W.AG

Initial state	Triggering condition	Set of actions	Final state
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & is_text(Frame)	DL_DATA.ind(extract_prty(Frame), extract_text(Frame)) Confirm=incr(Confirm) Ack_expected=FALSE Index = 0	*M.Send*
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & not(is_text(Frame))	Ack_expected=FALSE Index = 0	*M.Send*
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & Index<=MaxRetry	Phy_DATA.req(Fr) Index=Index+1	M.Rec
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & Index>MaxRetry	DL_ABORT.ind(EL-2F) Phy_ABORT.req()	W.EndS
M.Rec	DL_ABORT.req(Strong=0) & not(DL_DATA.req(_, _)) & Ack_expected=FALSE	Phy_ABORT.req()	W.EndS
M.Rec	DL_ABORT.req(Strong=1)	Phy_ABORT.req()	W.EndS
M.Rec	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	W.EndS

Table 24 – *Link-E/D* state transitions: Secondary Station

Initial state	Triggering condition	Set of actions	Final state
Initial	$true()	MaxRetry=2 FlagDSO=TRUE Discovered=FALSE Flag_alarm = FALSE	Stopped
Stopped	Phy_DATA.ind(Frame) & check_frame(Frame) & check_address(Frame)	ADP=extract_ADP(Frame) Com=command(Frame)	*T.Com*
Stopped	Phy_DATA.ind(Frame) & check_frame(Frame) & not(check_address(Frame))	Phy_ABORT.req()	Stopped
Stopped	Phy_DATA.ind(Frame) & not(check_frame(Frame))	$none()	Stopped
Stopped	DL_ALARM.req() & alarm_detection()	Phy_ABORT.req() Flag_alarm = TRUE Phy_ALARM.req()	Stopped
T.Com	Com=IB	FlagDSO=TRUE Discovered=FALSE Phy_ABORT.req()	Stopped
T.Com	Com=ASO & test_TABi(Frame, TAB)	Fr=concat(RSO, TAB, ADS) Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_RSO.req(Fr, window_RSO())	Stopped
T.Com	Com=ASO & not(test_TABi(Frame, TAB))	Phy_ABORT.req()	Stopped

Initial state	Triggering condition	Set of actions	Final state
T.Com	is_data+(Frame) & is_text(Frame)	Ack_expected=FALSE Send="11"B Confirm="00"B DL_DATA.ind(extract_prty, extract_text(Frame))	*M.Send*
T.Com	is_data+(Frame) & not(is_text(Frame))	Ack_expected=FALSE Send="11"B Confirm="00"B	*M.Send*
M.Send	exist_dl_data_req(DL_DATA.req(Pr=1, DSDU))	Discovered = TRUE Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index=1 Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.Send	not(DL_DATA.req(Pr=1, _)) & exist_dl_data_req(DL_DATA.req(Pr=0, DSDU))	Discovered = TRUE Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index=1 Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.Send	not(DL_DATA.req(_, _))	Pr=0 Fr="" Index=1 Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & is_text(Frame)	stop_timer(T1) Confirm=incr(Confirm) Ack_expected=FALSE DL_DATA.ind(extract_prty, extract_text(Frame))	*M.Send*
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & not(is_text(Frame))	stop_timer(T1) Ack_expected=FALSE	*M.Send*
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & Index<=MaxRetry	stop_timer(T1) Phy_DATA.req(Fr) Index=Index+1	M.Rec
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & Index>MaxRetry	stop_timer(T1) DL_ABORT.ind(EL-2F) Phy_ABORT.req()	Stopped
M.Rec	DL_ABORT.req(Strong=0) & not(DL_DATA.req(_, _)) & Ack_expected=FALSE	stop_timer(T1) Phy_ABORT.req()	Stopped
M.Rec	DL_ALARM.req() & alarm_detection()	stop_timer(T1) DL_ABORT.ind(EL_1F) Phy_ABORT.req() Flag_alarm = TRUE Phy_ALARM.req()	Stopped

Initial state	Triggering condition	Set of actions	Final state
M.Rec	DL_ABORT.req(Strong=1)	stop_timer(T1) Phy_ABORT.req()	Stopped
M.Rec	Phy_ABORT.ind(EP-1)	init_timer(T1)	M.Rec
M.Rec	Phy_ABORT.ind(ErrorNb) & ErrorNb <> EP-1	stop_timer(T1) DL_ABORT.ind(ErrorNb)	Stopped
M.Rec	time_out(T1)	DL_ABORT.ind(EL_3F)	Stopped

Table 25 – Meaning of the states listed in the previous tables

State	Meaning
Initial	Initialization of the variables of the layer
Stopped	Waiting state for the first request from the upper layer or the first indication from the lower layer
W.AG (Wait for end of "Wakeup Call")	Waiting for the end of a requested "Wakeup Call" signal
W.EndS (Wait for End of Session)	Waiting for the end of the session
T.Req (Test Request)	Test the nature of a request from the upper layer
M.RSO (Must receive RSO)	Waiting for an RSO frame following an ASO frame sent
T.RSO (Test last RSO)	Testing the end of the last time slot for RSO frame reception
M.Send (Must Send)	A frame shall be sent (possibly with the Text field empty)
M.Rec (Must Receive)	Waiting state for an indication from the lower layer
T.Com (Test Command)	Test of the command code of a received frame

Table 26 – Definition of the procedures and functions classified in alphabetical order

Procedure or function	Definition
Alarm_detection()	Check that the status of alarm mode is Active
build_RSO(ListRSO, Frame)	Extraction of the RSO elements (TAB and ADS fields) from the received RSO frame Frame and concatenation with the preceding list ListRSO
check_address(Frame)	Check that the ADP and ADS addresses are recognized according to the following criteria: – ADP is APG or the station has been programmed to the ADP address; – if the command code is ASO or IB, then ADS is ADG; – if the command code is not ASO nor IB, then ADS is the secondary station address
check_frame(Frame)	check that the frame Frame received is correct: – number of bytes greater than or equal to 11 and lower than or equal to 128; – CRC correct; – number of bytes compatible with the field Size; – command code recognized
com(DATA+, Pr, Send, Confirm)	Concatenation of the corresponding bit fields to produce a specific command code
command(Frame)	Extraction of the value of the command code of the received frame Frame
concat(Size, ADS, ADP, COM,Text) or concat(Frame, CRC)	Concatenation of the fields Size, ADS, ADP, COM and Text or concatenation of the CRC at the end of the frame Frame
context(ADS, ADP, TypeAG)	Extraction of the corresponding values from the communication context
crc(Frame)	Calculation of the CRC of the frame Frame to send
create_alarm(TPDU)	Calculation of a TPDU where STSAP = 0, DTSAP = 0 and an UnsolicitedReqPDU with: client-type = FFFF, serveridentifier = 0, object-name = FFFF variable type = boolean, value = TRUE
exist_dl_data_req(DL_DATA.req(Pr, DSDU))	Consumption of a DL_DATA.req(Pr, DSDU) event
exist_dl_req()	Check the existence of a DL_IB.req(), DL_ASO.req(DSDU) or DL_DATA.req(Pr, DSDU) event and check the compatibility with ADP and ADS addresses defined in the communication context
exist_dl_req(DL_IB.req()) or exist_dl_req(DL_ASO.req(DSDU))	Consumption of a DL_IB.req() or DL_ASO.req(DSDU) event
extract_ADP(Frame)	If either the ADP value used in the frame is not APG or if it is the APG value but the list of the ADP values to which the Secondary Station has been programmed is empty, then extraction of this value, otherwise extraction of the first ADP value to which the Secondary Station has been programmed
extract_prty(Frame)	Extraction of the Priority field from a received frame Frame
extract_text(Frame)	Extraction of the Text field from a received frame Frame
init(TypeAG)	Set Index to MaxRetry if TypeAG equals AGT, otherwise to 0
init_incrChain()	Set IncrChain to 0 if alarm supported, otherwise to 1
init_timer(T1)	Setting of wakeup T1
is_ack(Frame)	Check that the received frame Frame contains a Confirm field equal to the Send field of the last frame transmitted
is_data+(Frame)	Check that the received frame Frame contains a correct DATA+ field ("111"B)

Procedure or function	Definition
is_text(Frame)	Check that the received frame Frame contains a non-empty Text field and that the Send field equals the 1 complement of the Confirm field of the last frame transmitted
size(Frame)	Calculation of the size of the frame Frame received
size_frame(DSDU)	Calculation of the size of the frame to build with the DSDU data unit (size(DSDU) + 11)
stop_timer(T1)	Stopping of wakeup T1
test_TABi(Frame, TAB)	If the first TABi contained in the received ASO frame Frame equals 00, check that Discovered=FALSE then, after provision of a whole random integer between 0 and 100, check that this integer is smaller than the response probability (second TABi). In this case, 00 is memorized in the TAB variable; if the first TABi contained in the received ASO frame Frame equals FF, check that Flag_alarm=TRUE then, in this case, Flag_alarm is set to FALSE and FF is memorized in the TAB variable; If the first TABi contained in the received ASO frame Frame does not equal 00 or FF, check that FlagDSO=TRUE and check that the Secondary Station has been programmed to one of the TABi contained in the received ASO frame Frame. In this case, the first of these values is memorized in the TAB variable
time_out(T1)	Triggering of wakeup T1
window_RSO()	Provision of a whole random integer between 0 and MaxRSO-1 used as the number of the RSO time slot in which the station shall reply (refer to Annex F)

6.2.6 List and processing of errors

Errors are listed using the following codes:

EL = error in the *Data Link* layer
– = separator
N = error number
F = fatal error

Errors related to *Link-E/D* are specified in Table 27.

Table 27 – Error summary table

EL-1F	DL_ALARM.req() received during an association
	This request leads to the re-initialization of the *Data Link* layer after having requested the *Physical* layer to transmit an Alarm
EL-2F	Incorrect response from the Secondary Station after MaxRetry repeated transmissions of a request
	This error leads to the re-initialization of the *Data Link* layer after having informed the *Application* layer and caused the *Physical* layer to abort
EL-3F	End of communication due to expiration of delay T1
	This error leads to the re-initialization of the *Data Link* layer after having informed the *Application* layer and caused the *Physical* layer to abort

If any of these errors occur, it is sent up locally by means of the DL_ABORT.ind service primitive. The complete list of fatal error numbers is given in Annex C.

6.3 Application layer

6.3.1 General

The *Application* layer specification is described in IEC 62056-51. This subclause simply clarifies the operating profile for the local bus data exchange profile with DLMS.

6.3.2 Transport sub-layer

The value of the number MaxPktSize (refer to IEC 62056-51), maximum size of *Packet* field, shall be set at 114.

6.3.3 Application sub-layer

As stated in IEC 62056-51, the client_connect and server_connect functions shall be clarified according to the communication medium used. For the local bus data exchange profile with DLMS, the server_connect function is not accepted because the unsolicited service management is not supported. The client_connect function is defined in Table 28.

Table 28 – Client_connect function definition

Procedure or function	Definition
client_connect(Adp, Ads)	If there is no active application association, the function sets the context parameters ADS, ADP and TypeAG used by the lower layers. The function is transparent if there is already an application association active with the same (ADP, ADS) addresses. The function fails if there is already an application association with different (ADP, ADS) addresses.

7 Local bus data exchange with DLMS/COSEM

7.1 Model

The profile with DLMS/COSEM is different from the two other profiles in that the application layer is the DLMS/COSEM application layer specified in IEC 62056-5-3. This enables data exchange over the Euridis bus with equipment that follow the DLMS/COSEM application layer and the COSEM.

Another difference in this profile is the presence of a *Transport* layer and a *Support Manager* Layer.

7.2 Physical Layer

7.2.1 General

The protocol of the physical layer in the profile with DLMS/COSEM is identical to the protocol of the physical layer in the profiles with or without DLMS, up to the end of the correct negotiation of the transmission speed included. Once the speed negotiation phase is correctly completed, the DLMS/COSEM physical layer is applied. This is not different from the physical layer with or without DLMS, except the transmission speed, the value of the MaxIndex which shall be 255 and the modification of the time-out values TOL and TA10.

After a 'Wakeup Call' signal, asynchronous semi-duplex communication starts at 1 200 bauds, 8 bits without parity on the bus during the whole communication period without speed negotiation. After a successful speed negotiation, communication is asynchronous, semi-duplex, 8 bits without parity at the negotiated speed.

This speed negotiation only takes place for non energized equipment. For energized equipment, in order to respect consumption constraints, the communication speed stays at 1 200 bauds for the entire duration of the communication and the MaxIndex at 128 bytes. DLMS/COSEM operation under Euridis remains possible with these initial settings.

For non-energised equipment, operation with a DLMS/COSEM Application layer is possible with or without a change of speed. In the case where the application decides to change the speed, the relative speed negotiation settings takes place before the application associations are established.

7.2.2 Physical Parameters

Communication always starts at 1 200 bauds without parity, one stop bit. The maximum frame size is 128 bytes.

After speed negotiation, the newly negotiated speed is applied. The maximum frame size, MaxIndex, becomes 255 bytes.

The value of the maximum number of RSO time slots for the processing of a 'Forgotten Stations Call', MaxRSO, is set to 3.

The TOL timeout maximum response waiting time from an upper layer is increased to 1 s.

7.2.3 Speed negotiation

Management of the speed negotiation occurs in the *Support Manager* layer. The physical layer is informed of the new speed to apply, affecting the MaxIndex and TOL. As a consequence of the modification of the TOL value, following a speed negotiation, the maximum waiting time of the first received byte of a frame rises to a value higher than the TOL, depending on the application. By default this value is set to 1 100 ms.

7.2.4 E/COSEM Physical Services and service primitives

The *Physical E/COSEM* protocol includes services and service primitives listed in Table 29.

Table 29 – E/COSEM Physical services and service primitives

Service	Service primitive
Phy_DATA	Phy_DATA.req(Frame) Phy_DATA.ind(Frame)
Phy_UNACK	Phy_UNACK.req(Frame)
Phy_APPG	Phy_APPG.req(TypeAG) Phy_APPG.ind()
Phy_ASO	Phy_ASO.req(Frame) Phy_ASO.ind(Frame)
Phy_RSO	Phy_RSO.req(Frame, Window)
Phy_COLL	Phy_COLL.ind()
Phy_ALARM	Phy_ALARM_req() Phy_ALARM_ind()
Phy_ABORT	Phy_ABORT.req() Phy_ABORT.ind(ErrorNb)
Phy_SETUP	PHY_SETUP.req(params)

The role assigned to each primitive is as follows:

- Phy_DATA.req(Frame) enables the *Data Link* layer to request the *Physical* layer to transmit a frame Frame;
- Phy_DATA.ind(Frame) enables the *Physical* layer to inform the *Data Link* layer that a frame Frame is available;
- Phy_UNACK.req(Frame) enables the *Data Link* layer to request the *Physical* layer to transmit a frame Frame without waiting for acknowledgement;
- Phy_APPG.req (TypeAG) enables the *Data Link* layer to request the *Physical* layer to transmit a "Wakeup Call" signal. The duration TypeAG of this signal is either AGN or AGT;
- Phy_APPG.ind() enables the *Physical* layer to inform the *Data Link* layer of the end of the transmission of a "Wakeup Call" signal;
- Phy_ASO.req(Frame) enables the *Data Link* layer to request the *Physical* layer to transmit a "Forgotten Stations Call" frame;
- Phy_ASO.ind(Frame) enables the *Physical* layer to inform the *Data Link* layer that a frame Frame has been received in one of the time slots of the forgotten stations;
- Phy_RSO.req(Frame, Window) enables the *Data Link* layer to request the *Physical* layer to transmit a Forgotten Stations Call frame Frame in the time slot number Window;
- Phy_COLL.ind() enables the *Physical* layer to inform the *Data Link* layer that a collision has been detected in one of the time slots of the forgotten stations;
- Phy_ALARM.req() enables the *Data Link* layer to request the *Physical* layer to transmit an Alarm;
- Phy_ALARM.ind() enables the *Physical* layer to inform the *Data Link* layer of the arrival of an alarm;
- Phy_ABORT.req() enables the *Data Link* layer to request the *Physical* layer to end its activity;
- Phy_ABORT.ind(ErrorNb) enables the *Physical* layer to inform the *Data Link* layer of the occurrence of a fatal error identified by the number ErrorNb.
- Phy SETUP.req(params) enables the *Data Link* layer to request the *Physical* Layer to reconfigure itself according to the parameters related to the speed negotiation.

7.2.5 State transitions

E/COSEM Physical state transitions are as specified in Table 30, Table 31, Table 32 and Table 33.

Table 30 – *E/COSEM Physical* state transitions: Primary Station

Initial status	Initiation conditions	Actions	Final Status
Initial	$true()	MaxRSO=3 MaxIndex=128 Collision=FALSE SessionAGT=FALSE wait_time(TICB) Set_params(1200, TOL=100ms, TA10=120ms)	Stopped
Stopped	Phy_APPG.req(AG) & AG=AGN	stop_timer(TOAG) FlagAbort=FALSE TypeAG=AGN send_AG(TypeAG)	W.AG
Stopped	Phy_APPG.req(AG) & AG=AGT	SessionAGT=TRUE FlagAbort=FALSE TypeAG=AGT send_AG(TypeAG)	W.AG
Stopped	time_out(TOAG)	Phy_ABORT.ind(EP-2) SessionAGT=FALSE	*Initial*
Stopped	Phy_ABORT.req()	$none()	*Initial*
Stopped	data-carrier_on	init_timer(TAB) init_timer (TASB)	W.ETABS
W.ETABS	data_carrier_off	stop_timer(TASB) stop_timer(TAB)	*Initial*
W.ETABS	time_out(TAB)	Phy_ABORT.ind(EP-3) Phy_ALARM.ind()	W.TASB
W.AG	AG_sent_event	Phy_APPG.ind() init_timer(TEMPO)	W.TAB
W.AG	Phy_ABORT.req()	FlagAbort=TRUE	W.AG
W.TAB	data-carrier_on	Carrier = TRUE init_timer(TAB) init_timer (TASB)	W.TAB
W.TAB	data-carrier_off	Carrier = FALSE stop_timer(TAB) stop_timer (TASB)	W.TAB
W.TAB	time_out(TEMPO) & not(FlagAbort) & not(Carrier)	init_timer(TOL)	M.Send
W.TAB	time_out(TEMPO) & FlagAbort & not(Carrier)	wait_time (TOL)	*T.Session*
W.TAB	time_out(TEMPO) & Carrier	init_timer(TOL)	W.ETAB
W.TAB	Phy_ABORT.req()	FlagAbort=TRUE	W.TAB
W.ETAB	time_out(TAB)	Phy_ABORT.ind(EP-3) Phy_ALARM.ind() stop_timer(TOL)	W.TASB
W.ETAB	data_carrier_off & not(FlagAbort)	stop_timer(TAB) stop_timer (TASB)	M.Send
W.ETAB	data_carrier_off & FlagAbort	stop_timer(TAB) stop_timer (TASB)	W.TOL
W.ETAB	Phy_ABORT.req()	FlagAbort=TRUE	W.ETAB
W.TASB	time_out(TASB)	$none()	*Initial*
W.TOL	time_out(TOL)	$none()	*T.Session*
M.Send	Phy_DATA.req(Frame)	Service=NORMAL	*SendFirst*
M.Send	Phy_UNACK.req(Frame)	Service=UNACKNOWLEDGED	*SendFirst*
M.Send	Phy_ASO.req(Frame)	Service=ASO	*SendFirst*
M.Send	Phy_ABORT.req()	$none()	M.Send

Initial status	Initiation conditions	Actions	Final Status
M.Send	time_out(TOL)	$none()	*T.Session*
M.Send	PHY_SETUP(params)	Set_params(new baudrate, TOL=1000ms TA10=1100ms,) MaxIndex=255	M.Send
T.Session	SessionAGT=TRUE	init_timer(TOAG) Phy_ABORT.ind(EP-1) wait_time(TEMPO)	*Initial*
T.Session	SessionAGT=FALSE	Phy_ABORT.ind(EP-1) wait_time(TEMPO)	*Initial*
SendFirst	$true()	stop_timer(TOL) Size=size(Frame) Index=1 send_octet(Frame, Index) Size=Size-1 init_timer(TOE)	Sending
Sending	octet_sent_event & Size>0	Index=Index+1 send_octet(Frame, Index) Size=Size-1	Sending
Sending	octet_sent_event & Size=0	stop_timer(TOE) wait_time(TAO) Index=1 Frame=""	*Answer*
Sending	Phy_ABORT.req()	stop_timer(TOE) wait_time(TAO) init_timer(TA1O) FlagAbort=TRUE	M.Rec
Sending	time_out(TOE)	Phy_ABORT.ind(EP-3F) wait_time(TAO) init_timer(TA1O) FlagAbort=TRUE	M.Rec
Answer	Service=NORMAL I Service=UNACKNOWLEDGED	init_timer(TA1O)	M.Rec
Answer	Service=ASO	WinRSO=1 init_timer(TARSO) init_timer(TA1O)	M.Rec
M.Rec	octet_received_event	stop_timer(TA1O) Index=Index+1 read_data(RecB) concat(Frame, RecB) init_timer(TAO)	Receiving
M.Rec	Collision_detected_event	stop_timer(TA1O) Collision=TRUE init_timer(TAO)	Receiving
M.Rec	time_out(TA1O)	$none()	*Received*
M.Rec	Phy_ABORT.req()	FlagAbort=TRUE	M.Rec
Receiving	octet_received_event & Index<=MaxIndex	stop_timer(TAO) Index=Index+1 read_data(RecB) concat(Frame, RecB) init_timer(TAO)	Receiving
Receiving	octet_received_event & Index>MaxIndex	Phy_ABORT.ind(EP-4F) wait_time(TAO) FlagAbort=TRUE	*Received*
Receiving	Collision_detected_event	stop_timer(TAO) Collision=TRUE init_timer(TAO)	Receiving
Receiving	time_out(TAO)	$none()	*Received*

Initial status	Initiation conditions	Actions	Final Status
Receiving	time_out(TARSO)	Phy_ABORT.ind(EP-5F) wait_time(TAO) FlagAbort=TRUE	*Received*
Receiving	Phy_ABORT.req()	Flagabort = TRUE	Receiving
Received	Service=NORMAL & not(Flagabort)	Phy_DATA.ind(Frame) init_timer(TOL)	M.Send
Received	(Service=NORMAL & Flagabort) | Service=UNACKNOWLEDGED	wait_time(TOL)	*T.Session*
Received	Service=ASO & Collision & not(Flagabort)	Phy_COLL.ind() Collision=FALSE	*T.RSO*
Received	Service=ASO & not(Collision) & not(Flagabort)	Phy_ASO.ind(Frame)	*T.RSO*
Received	Service=ASO & Flagabort	$none()	*T.RSO*
T.RSO	(TypeAG=AGT) I (WinRSO>=MaxRSO) & (TypeAG=AGN)	stop_timer(TARSO)	*T.Session*
T.RSO	(WinRSO<MaxRSO) & (TypeAG=AGN)	Index=1 Frame=""	W.RSO
W.RSO	time_out(TARSO)	WinRSO=WinRSO+1 init_timer(TARSO) init_timer(TA1O)	M.Rec
W.RSO	Phy_ABORT.req()	Flagabort=TRUE	W.RSO

Table 31 – Power supply management state transitions (only for non-energized Secondary Station)

Initial State	Triggering condition	Set of actions	Final state
Initial	alarm_detection()	Flagalarm=TRUE FlagSendAlarm =FALSE station_power(ON) Set_params(1200, TOL=100ms, TA10=120ms) MaxIndex=128	Stopped
Initial	not(alarm_detection())	Flagalarm=FALSE Set_params(1200, TOL=100ms, TA10=120ms) MaxIndex=128	Stopped
Stopped	occur(cpt_carrier_on) & Flagalarm	init_timer(TVASB)	W.TVASB2
Stopped	occur(data_carrier_on)	init_timer(TOSEUIL) init_timer(TAGT)	W.TOSEUIL
W.TOSEUIL	time_out(TOSEUIL)& not(Flagalarm)	station_power(ON)	W.AGT
W.TOSEUIL	occur(data_carrier_off) & not(Flagalarm)	stop_timer(TOSEUIL) stop_timer(TAGT)	*Initial*
W.TOSEUIL	time_out(TOSEUIL) & Flagalarm	station_signal(ON) Tend = TOAG	W.AGT
W.TOSEUIL	occur(data_carrier_off) & Flagalarm	stop_timer(TOSEUIL) stop_timer(TAGT) Tend = TOAGN init_timer(Tend)	Hide
W.TOSEUIL	occur(cpt_carrier_on) & Flagalarm	init_timer(TVASB)	W.TVASB1
W.AGT	occur(data_carrier_off)	stop_timer(TAGT) init_timer(TOAPPEL)	W.Sel
W.AGT	time_out(TAGT) & not(Flagalarm)	station_power(OFF)	*Initial*

Initial State	Triggering condition	Set of actions	Final state
W.AGT	time_out(TAGT) & Flagalarm	init_timer(Tend)	Hide
W.Sel	occur(octet_received_event)	stop_timer(TOAPPEL) init_timer(TOBAVARD) init_timer(TAO)	Select
W.Sel	time_out(TOAPPEL) & not(Flagalarm)	station_power(OFF)	*Initial*
W.Sel	time_out(TOAPPEL) & Flagalarm	station_signal(OFF)	*Initial*
W.Sel	occur(cpt_carrier_on) & Flagalarm & not(FlagSendalarm)	init_timer(TVASB)	W.TVASB1
Select	occur(octet_received_event)	stop_timer(TAO) init_timer(TAO)	Select
Select	time_out(TAO)	stop_timer(TOBAVARD) init_timer(TOPRE)	W.Answer
Select	time_out(TOBAVARD) & not(Flagalarm)	stop_timer(TAO) station_power(OFF)	*Initial*
Select	time_out(TOBAVARD) & Flagalarm	stop_timer(TAO) init_timer(Tend)	Hide
W.Answer	occur(octet_sent_event)	stop_timer(TOPRE) init_timer(Tend)	Hide
W.Answer	time_out(TOPRE) & not(Flagalarm)	station_power(OFF)	*Initial*
W.Answer	time_out(TOPRE) & Flagalarm	init_timer(Tend)	Hide
W.Answer	occur(cpt_carrier_on) & Flagalarm & not(FlagSendalarm)	init_timer(TVASB)	W.TVASB1
Hide	occur(octet_received_event) | occur(octet_sent_event) I (occur(data_carrier_on) & not(FlagSendAlarm))	stop_timer(Tend) init_timer(Tend)	Hide
Hide	occur(data_carrier_on) & FlagSendAlarm	stop_timer(Tend)	W.AGend
Hide	time_out(Tend) & not(Flagalarm)	station_power(OFF)	*Initial*
Hide	time_out(Tend) & Flagalarm & not(FlagSendAlarm)	station_signal(OFF)	*Initial*
Hide	time_out(Tend) & Flagalarm & FlagSendAlarm	Send_AG(AGN)	W.AB
Hide	occur(cpt_carrier_on) & Flagalarm & not(FlagSendalarm)	init_timer(TVASB)	W.TVASB1
W.AGend	occur(data_carrier_off)	wait_time(TOALR) Send_AG(AGN)	W.AB
W.TVASB1	occur(cpt_carrier_off)	stop_timer(TVASB) init_timer(Tend)	Hide
W.TVASB1	time_out(TVASB)	FlagSendAlarm = TRUE init_timer(Tend)	Hide
W.TVASB1	time_out(Tend)	$none()	W.TVASB2
W.TVASB2	occur(cpt_carrier_off)	stop_timer(TVASB) station_signal(OFF)	*Initial*
W.TVASB2	occur(data_carrier_on)	$none()	W.TVASB1
W.TVASB2	time_out(TVASB)	Send_AG(AGN)	W.AB
W.AB	AG_sent_event	FlagSendAlarm = FALSE station_signal(OFF)	*Initial*

Table 32 – *E/COSEM Physical* State transitions: Secondary Station

Initial state	Triggering condition	Set of actions	Final state
Initial	energized()	MaxIndex=128 FlagRSO=FALSE FirstWinRSO=FALSE Setup_params(1200, TOL=100ms, TA10=160ms) MaxIndex=128,	Stopped
Initial	not(energized())	MaxIndex=18 FlagRSO=FALSE FirstWinRSO=TRUE Setup_params(1200, TOL=100ms, TA10=120ms)	Stopped
Stopped	AG_received_event	Stop_timer(TOAG) init_timer(TA1O)	M.Rec
Stopped	Phy_ALARM.req()	TypeAG=ASB Send_AG(TypeAG)	W.ASB
Stopped	time_out(TOAG)	MaxIndex=18 FirstWinRSO=TRUE	*Initial*
M.Rec	octet_received_event	Stop_timer(TA1O) Index=2 Frame="" Read_data(RecB) Concat(Frame, RecB) Init_timer(TAO)	Receiving
M.Rec	time_out(TA1O)	Phy_ABORT(EP-1)	*WTOAG*
M.Rec	Phy_ABORT.req()	Stop_timer(TA1O)	*WTOAG*
M.Rec	PHY_SETUP(params)	Setup_params(new baudrate, TOL=1000ms, TA10=1100ms) See NOTE MaxIndex=255,	M.Rec
Receiving	octet_received_event & Index<=MaxIndex	Stop_timer(TAO) Index=Index+1 Read_data(RecB) Concat(Frame, RecB) Init_timer(TAO)	Receiving
Receiving	octet_received_event & Index>MaxIndex	Stop_timer(TAO) Phy_ABORT.ind(EP-4F)	*WTOAG*
Receiving	time_out(TAO)	Phy_DATA.ind(Frame) Init_timer(TOL)	M.Send
Receiving	Phy_ABORT.req()	Stop_timer(TAO)	*WTOAG*
M.Send	Phy_DATA.req(Frame)	Stop_timer(TOL) Size=size(Frame) Index=1 Send_octet(Frame, Index) Size=Size-1 Init_timer(TOE)	Sending
M.Send	Phy_RSO.req(Frame, Window)	Stop_timer(TOL) Wait_window(FirstWinRSO, Window) FirstWinRSO=FALSE Size=size(Frame) Index=1 Send_octet(Frame, Index) Size=Size-1 FlagRSO=TRUE Init_timer(TOE)	Sending
M.Send	time_out(TOL)	Init_timer(TA1O)	M.Rec

Initial state	Triggering condition	Set of actions	Final state
M.Send	Phy_ABORT.req()	Stop_timer(TOL)	*WTOAG*
Sending	octet_sent_event & Size>0	Index=Index+1 Send_octet(Frame, Index) Size=Size-1	Sending
Sending	octet_sent_event & Size=0 & not(FlagRSO)	Stop_timer(TOE) init_timer(TA1O)	M.Rec
Sending	octet_sent_event & Size=0 & FlagRSO	Stop_timer(TOE) Wait_time(TAO) FlagRSO=FALSE	*WTOAG*
Sending	Phy_ABORT.req()	Stop_timer(TOE)	*WTOAG*
Sending	time_out(TOE)	Phy_ABORT.ind(EP-3F)	*WTOAG*
W.ASB	time_out(TOAG)	MaxIndex=18 FirstWinRSO=TRUE	W.ASB
W.ASB	AG_sent_event	$none()	*Initial*
WTOAG	Not(energized)	init_timer(TOAG)	*Initial*
WTOAG	energized	$none()	*Initial*

NOTE Some operating sytems do not allow the modification of the timeout when the timer linked to this timeout is in progress. These devices may update the values of the timeout only at the next reception sequence.

Table 33 – Meaning of the states listed in the previous tables

State	Definition
Initial	Initialisation of the variables of the layer
Stopped	Waiting for a ‘Wakeup Call’ signal
W.ETABS (Wait for end of " Alarm-Bus ")	Waiting for the end of an ‘Alarm Bus’ signal, received in a Stopped state
W.AG (Wait for end of " Wakeup Call ")	Waiting for the end of a ‘Wakeup Call’ signal transmission.
W.TAB (Wait " Alarm-Bus ")	Waiting for an alarm bus signal during safety delay at the end of transmission of a ‘wakeup Call’ signal
W.ETAB (Wait for end of " Alarm-Bus ")	Waiting for an end of an ‘Alarm Bus’ signal received after the transmission of a ‘Wakeup Call’ signal.
W.TASB	Waiting for the triggering of wakeup TASB after the begin of the reception of an "Alarm-Bus" signal
W.TOL	Waiting for the triggering of wakeup TOL
M.Send (Must Send)	Initial state of the transmitter waiting for a frame to send
T.Session	Testing the type of the session (with an energized or not energized Secondary Station)
SendFirst	Sending the first byte of the frame to be sent
Sending	Recurrent state of the transmitter transmitting one byte at a time
Answer	Branching depending on the service requested
M.Rec (Must Receive)	Initial state of the receiver waiting for the first byte of a frame
Receiving	Recurrent state of the receiver receiving one byte at a time
Received	Processing the received frame
T.RSO (Test last RSO)	Testing the end of the last time slot for RSO frame reception

State	Definition
W.RSO (Wait for end of an RSO time slot)	Waiting for the end of a time slot for RSO frame reception
W.ASB	Waiting for the end of a "Alarm Secondary-Bus" signal transmission
W.TOAG	Initializing the "end of session" TOAG timer if needed
W.TOSEUIL	Waiting for the triggering of wakeup TOSEUIL
W.AGT	Waiting for an AGT "Wakeup Call" signal
W.Sel (Wait for preSelection)	Waiting for a preselection frame
Select	Receiving a preselection frame
W.Answer	Waiting for an answer frame from a selected station
Hide	Waiting for the end of selection
W.Agend	Waiting for the end of AG reception
W.TVASB1	Waiting for the triggering of wakeup TVASB for an "Alarm Secondary-Bus" signal during a session
W.TVASB2	Waiting for the triggering of wakeup TVASB for an "Alarm Secondary-Bus" signal at the end of session
W.AB	Waiting for the end of a "Alarm Bus" signal transmission

Table 34 – Definition of the procedures, functions and events classified in alphabetical order

Procedure, function or event	Definition
AG_received_event	Event from the modem reporting that an AGN "Wakeup Call" signal has been correctly detected
AG_sent_event	Event from the modem reporting the end of the transmission of a "Wakeup Call" signal
alarm_detection()	Check that the station status of alarm mode is Active
collision_detected_event	Event from the modem reporting the detection of a framing error on reception of a byte
concat(Frame, RecB)	Concatenation of the byte RecB in the being built frame Frame
data_carrier_on, data_carrier_off	Occurrence of the detection on the bus of the data carrier on, the data carrier off
energized()	Check that the station is energized
init_timer(TOAPPEL), init_timer(TOSEUIL), init_timer(TAGT), init_timer(TOBAVARD), init_timer(TOPRE), init_timer(TOL), init_timer(TOE), init_timer(TAO), init_timer(TA1O), init_timer(TARSO) init_timer(TOAG), init_timer(TVASB) or init_timer(TAB)	setting of wakeup TOAPPEL, TOSEUIL, TAGT, TOBAVARD, TOPRE, TOL, TOE, TAO, TA1O, TARSO, TOAG, TVASB or TAB
occur(cpt_carrier_on), occur(cpt_carrier_off), occur(data_carrier_on), occur(data_carrier_off), occur(octet_received_event) or occur(octet_sent_event)	Occurrence (reporting without consuming) of the detection on the secondary bus of the data carrier on, the data carrier off, on the bus of the data carrier on, the data carrier off, the reception of a byte or the emission of a byte
octet_received_event	Event from the modem reporting that a byte has been received

Procedure, function or event	Definition
octet_sent_event	Event from the modem reporting that a byte has been sent
read_data(RecB)	Processing of the byte_received_event event by reading the received RecB byte (bits are transmitted in ascending order)
send_AG(TypeAG)	Request to the modem for transmission of a "Wakeup Call" signal of duration TypeAG (AGN or AGT)
send_octet(Frame, Index)	Transmission of the byte of rank Index in the frame Frame (bits are transmitted in ascending order)
Setup_params(baurdate, TOL, TA10)	Setup of the parameters baudrate, TOL and TA10.
size(Frame)	Calculation of the number of bytes of the frame Frame
station_power(ON) or station_power(OFF)	Turning ON or OFF the energy supply to the device
station_signal(ON) or station_signal(OFF)	Turning ON or OFF the signal transmission to the device on the secondary bus
stop_timer(TOAPPEL), stop_timer(TOSEUIL), stop_timer(TAGT), stop_timer(TOBAVARD), stop_timer(TOPRE), stop_timer(TOL), stop_timer(TOE), stop_timer(TAO), stop_timer(TA1O), stop_timer(TVASB) or stop_timer(TAB)	Stopping of wakeup TOAPPEL, TOSEUIL, TAGT, TOBAVARD, TOPRE, TOL, TOE, TAO,TA1O, TVASB or TAB
stop_timer(TOAG) or stop_timer(TARSO)	Stopping of wakeup TOAG or TARSO only if it has previously been set
time_out(TOAPPEL), time_out(TOSEUIL), time_out(TAGT), time_out(TOBAVARD), time_out(TOPRE), time_out(TOL), time_out(TOE), time_out(TAO), time_out(TA1O), time_out(TARSO), time_out(TOAG), time_out(TVASB) or stop_timer(TAB)	Triggering of wakeup TOAPPEL, TOSEUIL, TAGT, TOBAVARD, TOPRE, TOL, TOE, TAO, TA1O, TARSO, TOAG, TVASB or TAB
wait_time(TAO), wait_time(TICB), wait_time(TOL) or wait_time(TOALR)	Calculated delay during time TAO, TICB, TOL or TOALR
wait_window(FirstWinRSO, Window)	Wait-time calculated as follows: when FirstWinRSO=TRUE or Window=0 ==> 0 ms when FirstWinRSO=FALSE and Window>0 ==> 40 ms + (TARSO*Window) ms (The 40 ms delay guarantees that the transmission has taken place in the time slot)

Errors related *to E/COSEM* are specified in Table 35.

Table 35 – Error summary table

EP-1	Expiry of TOL wakeup (Primary Station) before the Data Link layer requests a frame transmission or expiry of TA1O wakeup (Secondary Station) before any character has been received from the Primary station
	This error leads to the expectation of a "Wakeup Call" signal after having informed the Data Link layer
EP-2	Expiry of TOAG wakeup before any "Wakeup Call" signal
	This error leads to the expectation of a "Wakeup Call" signal after having informed the Data Link layer
EP-3	An alarm has been received
	This error leads to the reinitialization of the Physical layer after having informed the Data Link layer
EP-3F	Abnormal length of transmission detected after expiry of TOE wakeup
	This error leads to the reinitialization of the Physical layer after having informed the Data Link layer
EP-4F	Number of bytes received higher than MaxIndex (Transmitter too talkative)
	This error leads to the reinitialization of the Physical layer after having informed the Data Link layer
EP-5F	Expiry of TARSO wakeup while receiving an RSO frame (Primary Station only)
	This error leads to the reinitialization of the Physical layer after having informed the Data Link layer

If any of these errors occurs, it is sent up locally by means of the Phy_ABORT.ind service primitive. The complete list of fatal error numbers is given in Annex C.

7.3 Data Link layer

7.3.1 General

The *Data Link* Layer used for local bus data exchange with DLMS/COSEM is based on the same principle as the *Data Link E/D* layer used for data exchange with DLMS. The only difference is the interaction with the upper layers and processing of the speed negotiation.

At the upper level, the *Data link* layer interfaces the transport layer and the communication *Support Manager* layer.

7.3.2 Identification of data units

The Data Link layer delivers all PDUs identified as DATA+ to the DLMS/COSEM Transport layer. All other PDUs are directed towards the Support Manager layer, which recognises and processes known PDUs; unknown PDUs are simply ignored. See Table 41 for the Support Manager commands.

7.3.3 Role of the Data Link layer

The purpose of the *Data Link* layer is to:

- carry out serialization and deserialization of the data;
- synchronise the transmission and reception frames;
- filter the frames according to primary and secondary addresses;
- ensure efficient protection against transmission errors.

7.3.4 Management of exchanges

At the Transmitter end, all data frames that are sent shall receive a positive acknowledgement from the Receiver station before sending the next data frame. After sending a frame and receiving the acknowledgement of the previously sent frame, the current frame is transmitted. The number of repetitions is limited to MaxRetry. Above this number, the communication is stopped at the Data Link level and a notification is sent to the Transport layer and Manager Support layer.

Each time a frame is received, an answer frame is transmitted within a delay compatible with the TOL managed by the Physical layer. If the transport layer does not have any data available to transmit, *a* DSDU with a Text empty field is sent, notifying the acknowledgement or non-acknowledgement of the received DPDU.

The management principle of acknowledgement / non-acknowledgement is identical to that specified in 6.2.2.

7.3.5 Data Link services and service primitives

Data link services are as specified in Table 36.

Table 36 – Data Link services and service primitives

Service	Service primitive
DL_DATA	DL_DATA.req(Pr,Service class, DSDU) DL_DATA.ind(Pr,Service class, DSDU)
DL_ALARM	DL_ALARM.req() DL_ALARM.ind()
DL_ABORT	DL_ABORT.req(Strong) DL_ABORT.ind(ErrorNb)
DL_IB	DL_IB.req() DL_IB.ind()
DL_Discover	DL_Discover.req() DL_Discover.ind()
DL_ChangeBaudrate	DL_ChangeBaudrate.req() DL_ChangeBaudrate.ind()
DL_PhysicalSetupParameters	DL_PhysicalSetup.req(params)

The role assigned to each primitive is as follows:

DL_DATA.req(Pr, Sevice class, DSDU) enables the upper layer (*Transport* or *Support Manager*) to request the *Data Link* layer to transfer a DSDU data packet with the priority Pr[5], with service class CONFIRMED or UNCONFIRMED. In the request, the service class parameter only concerns the primary station. As long as the service class is UNCONFIRMED, the *Data Link* layer of the primary station shall use a broadcast destination address;

DL_DATA.ind(Pr, Service class, DSDU) enables the *Data Link* layer to inform the upper layer of the arrival of a DSDU data packet with the priority Pr. In the indication, the service class parameter only concerns the secondary station. As long as the destination address is a broadcast address, the secondary station data link layer shall set the Service_class parameter to UNCONFIRMED for the upper layer;

DL_ALARM.req()enables the *Support Manager* layer of the secondary station to request the *Data Link* layer to send an alarm;

DL_ALARM.ind()enables the *Data Link* layer of the primary station to warn the *Support Manager* layer of the presence of an Alarm;

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5 The priority level Pr differentiates the processing of emergency services such as InformationReport (level Pr=1) from that of the other DLMS services (level Pr=0).

DL_ABORT.req(Strong[6])enables the upper layers to request the *Data Link* layer to end its activity with the priority Strong;

DL_ABORT.ind(ErrorNb) enables the *Data Link* layer to inform the *Support Manager* layer of the occurrence of a fatal error identified by the number ErrorNb;

DL_IB.req() enables the *Support Manager* layer of the primary station to request the *Data Link layer to* initialise the bus;

DL_IB.ind() enables the secondary station *Data Link* layer to inform the *Support Manager* layer of the presence of an initialisation of the bus;

DL_Discover.req() enables the *Support Manager* layer to request the *Data Link* layer to send a call to forgotten stations frame;

DL_Discover.ind() enables the *Data Link* layer to inform the *Support Manager* layer of the presence of a call to forgotten stations frame;

DL_ChangeBaudrate.req() enables the *Support Manager* layer to request the *Data Link* layer to send a speed negotiation frame;

DL_ChangeBaudrate.ind() enables the *Data Link* layer to inform the *Support* Manager layer of the presence of a speed negotiation frame;

DL_PhysicalSetupParameters.req(Params) enables the *Support Manager* layer to request the *Data Link* layer to carry out the modification of the settings related to a change of speed. These settings consist of the negotiated baudrate, the Timeout TOL that has passed 1 s, the timeout TA10 of 1 100 ms and MaxIndex which increases from 128 to 255 bytes.

7.3.6 Data Link parameters

The Data Link parameters are the same as for the Data Link layer in the profile with DLMS, see 6.2.4.

At the end of the baud rate change process, at the primary device side the Data Link layer manages a timeout TES (time out end of Setup) of 50 ms before processing all new requests destined for the secondary device. This is to allow the equipment to correctly set up the UART.

7.3.7 State transitions

DLMS/COSEM Data Link E/D state transitions are as specified in Table 37, Table 38, Table 39 and Table 40.

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6 The Strong parameter differentiates the processing of fatal errors (Strong=1) from that of the other physical disconnection requests (Strong=0) initialized by the *Application* sub-layer.

Table 37 – *DLMS/COSEM Data Link E/D* state transitions: Primary Station

Initial State	Triggering Conditions	Set of actions	Final State
Initial	$true()	MaxRetry=2 MaxChain = 5 init_incrChain()	Stopped
Stopped	exist_dl_req()	NbChain = 0 MaxIndex=0 RepeatASO=FALSE context(ADP, ADS, TypeAG) init(TypeAG) Phy_APPG.req(TypeAG)	W.AG
Stopped	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	Stopped
Stopped	Phy_ALARM.ind()	DL_ALARM.ind()	Stopped
W.AG	Phy_APPG.ind() & not(RepeatASO) & NbChain = 0	$none()	*T.Req*
W.AG	Phy_APPG.ind() & not(RepeatASO) & NbChain <> 0	NbChain = 0	*M.Send*
W.AG	Phy_APPG.ind() & RepeatASO	RepeatASO=FALSE Phy_ASO.req(Fr)	M.RSO
W.AG	DL_ABORT.req(_)	Phy_ABORT.req()	W.EndS
W.EndS	(Phy_ABORT.ind(EP-2) & TypeAG=AGT) I (Phy_ABORT.ind(EP-1) & TypeAG=AGN)	$none()	Stopped
W.EndS	Phy_ALARM.ind	DL_ALARM.ind()	Stopped
W.EndS	Phy_ABORT.ind(ErrorNb) & ErrorNb<>EP-1 & ErrorNb<>EP-2	DL_ABORT.ind(ErrorNb)	W.EndS
T.Req	exist_dl_req(DL_IB.req())	Fr="" Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, IB, Fr) Fr=concat(Fr, crc(Fr)) Phy_UNACK.req(Fr)	W.EndS
T.Req	exist_dl_req(DL_Discover.req(DSDU)) & TypeAG=AGN	MaxRSO=3 NbRSO=1 ListRSO="" Collision=FALSE Fr=DSDU Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, ASO, Fr) Fr=concat(Fr, crc(Fr)) Phy_ASO.req(Fr)	M.RSO
T.Req	exist_dl_req(DL_Discover.req(DSDU)) & TypeAG=AGT	MaxRSO=1 NbRSO=1 ListRSO="" Collision=FALSE Fr=DSDU Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, ASO, Fr) Fr=concat(Fr, crc(Fr)) Phy_ASO.req(Fr)	M.RSO
T.Req	not (exist_dl_req(DL_IB.req()) | exist_dl_req(DL_ Discover.req(_)))	Pr=0 Send="00"B Confirm="11"B Fr="" Index=Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec

Initial State	Triggering Conditions	Set of actions	Final State
T.Req	exist_dl_req(DL_XBR.req(proposed_baudrate)	Fr="proposed_baudrate" Index=Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, XBR, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.RSO	Phy_ASO.ind(Frame) & size(Frame)=0	$none()	*T.RSO*
M.RSO	Phy_ASO.ind(Frame) & check_frame(Frame) & command(Frame)=RSO	build_RSO(ListRSO, Frame)	*T.RSO*
M.RSO	Phy_ASO.ind(Frame) & not(check_frame(Frame)) & size(Frame)<>0	Collision=TRUE	*T.RSO*
M.RSO	Phy_COLL.ind()	Collision=TRUE	*T.RSO*
M.RSO	DL_ABORT.req(_)	Phy_ABORT.req()	W.EndS
M.RSO	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	W.EndS
T.RSO	MaxRSO=1 & Collision	MaxRSO=3 Collision=FALSE RepeatASO=TRUE Phy_APPG.req(AGN)	W.AG
T.RSO	(MaxRSO=1 & not(Collision)) | (MaxRSO<>1 & NbRSO>=MaxRSO)	DL_Discover.ind (Collision, ListRSO)	W.EndS
T.RSO	NbRSO<MaxRSO	NbRSO=NbRSO+1	M.RSO
M.Send	exist_dl_data_req(DL_DATA.req(Pr=1, Service class DSDU)) & ((& not(TreqTimout))) NbChain < MaxChain	Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index= Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) Stop_timer(Treq)	M.Rec
M.Send	not(DL_DATA.req(Pr=1, _)) & exist_dl_data_req(DL_DATA.req(Pr=0, Service class DSDU)) & ((& not(TreqTimout))) NbChain < MaxChain	Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index= Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) Stop_timer(Treq)	M.Rec
M.Send	not(DL_DATA.req(_, _)) & TreqTimeout()& NbChain < MaxChain	Pr=0 Fr="" Index= Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) initTimer(Treq)	M.Rec
M.Send	NbChain >= MaxChain	Phy_APPG.req(AGN)	W.AG

Initial State	Triggering Conditions	Set of actions	Final State
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & is_text(Frame)	DL_DATA.ind(extract_prty(Frame), extract_text(Frame)) Confirm=incr(Confirm) Ack_expected=FALSE Index = 0 initTimer(Treq)	*M.Send*
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & not(is_text(Frame))	Ack_expected=FALSE Index = 0 initTimer(Treq)	*M.Send*
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & Index<=MaxRetry	Phy_DATA.req(Fr) Index=Index+1	M.Rec
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & Index>MaxRetry	DL_ABORT.ind(EL-2F) Phy_ABORT.req()	W.EndS
M.Rec	DL_ABORT.req(Strong=0) & not(DL_DATA.req(_, _)) & Ack_expected=FALSE	Phy_ABORT.req()	W.EndS
M.Rec	DL_ABORT.req(Strong=1)	Phy_ABORT.req()	W.EndS
M.Rec	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	W.EndS
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & (check_address(Frame) & (Com =XBA)	DL_ChangeBaudrate.ind(accepted_baurdate).	M.Rec
M.Rec	exist_dl_physical_setup_req(params)	Phy_SETUP(params) wait(TES)	T.Req

Table 38 – *DLMS/COSEM Link E/D* state transitions: Secondary Station

Initial State	*Triggering conditions*	Set of actions	Final State
Initial	*$true()*	MaxRetry=2 FlagDSO=TRUE Discovered=FALSE Flag_alarm=FALSE	Stopped
Stopped	*Phy_DATA.ind(Frame) & check_frame(Frame) & check_address(Frame)*	ADP=extract_ADP(Frame) Com=command(Frame)	*T.Com*
Stopped	*Phy_DATA.ind(Frame) & check_frame(Frame) & not(check_address(Frame))*	Phy_ABORT.req()	Stopped
Stopped	*Phy_DATA.ind(Frame) & not(check_frame(Frame))*	$none()	Stopped
Stopped	*DL_Alarm.req()*	Phy_ABORT.req() Flag_alarm = TRUE Phy_ALARM.req()	Stopped
T.Com	*Com=IB*	Discovered=FALSE DL_IB.ind() Phy_ABORT.req()	Stopped
T.Com	*Com=ASO & test_TABi(Frame, TAB)*	DL_Discover.ind(TAB)	W.MM
T.Com	*Com=XBR*	DL_ChangeBaudrate.ind(proposed_baudrate)	W.MM

Initial State	*Triggering conditions*	Set of actions	Final State
T.Com	*is_data+(Frame) & is_text(Frame)*	Ack_expected=FALSE Send="11"B Confirm="00"B DL_DATA.ind(extract_prty, extract_text(Frame)) initTimer(Treq)	*M.Send*
T.Com	*is_data+(Frame) & not(is_text(Frame))*	Ack_expected=FALSE Send="11"B Confirm="00"B initTimer(Treq)	*M.Send*
W.MM	*exist_dl_discover_req(TAB)*	Fr=concat(RSO, TAB, ADS) Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_RSO.req(Fr, window_RSO())	*stopped*
W.MM	*exist_dl_discover_req(not(TAB))*	Phy_ABORT.req()	*stopped*
W.MM	*exist_dl_change_baud_rate.req(acceptedBaudrate)*	Discovered = TRUE Fr= acceptedBaudrate Index=1 Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, XBA, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	*M.Rec*
M.Send	*exist_dl_data_req(DL_DATA.req(Pr=1, DSDU)) & not(Treqtimeout())*	Discovered = TRUE Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index=1 Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) Stop_timer(Treq)	M.Rec
M.Send	*not(DL_DATA.req(Pr=1, _)) & exist_dl_data_req(DL_DATA.req(Pr=0, DSDU)) & not(Treqtimeout())*	Discovered = TRUE Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index=1 Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) Stop_timer(Treq)	M.Rec
M.Send	*not(DL_DATA.req(_, _))& TreqTimeout()*	Pr=0 Fr="" Index=1 Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) initTimer(Treq)	M.Rec
M.Rec	*Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & is_text(Frame)*	Confirm=incr(Confirm) Ack_expected=FALSE DL_DATA.ind(extract_prty, extract_text(Frame)) initTimer(Treq)	*M.Send*
M.Rec	*Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & not(is_text(Frame))*	Ack_expected=FALSE initTimer(Treq)	*M.Send*

Initial State	*Triggering conditions*	Set of actions	Final State
M.Rec	*Phy_DATA.ind(Frame) & not(check_frame(Frame) &* *check_address(Frame) &* *is_data+(Frame) &* *is_ack(Frame)) &* *Index<=MaxRetry*	Phy_DATA.req(Fr) Index=Index+1	M.Rec
M.Rec	*Phy_DATA.ind(Frame) & not(check_frame(Frame) &* *check_address(Frame) &* *is_data+(Frame) &* *is_ack(Frame)) &* *Index>MaxRetry*	DL_ABORT.ind(EL-2F) Phy_ABORT.req()	Stopped
M.Rec	*DL_ABORT.req(Strong=0) & not(DL_DATA.req(_, _)) & Ack_expected=FALSE*	Phy_ABORT.req()	Stopped
M.Rec	*DL_ALARM.req() &* *alarm_detection()*	DL_ABORT.ind(EL_1F) Phy_ABORT.req() Flag_alarm = TRUE Phy_ALARM.req()	Stopped
M.Rec	*DL_ABORT.req(Strong=1)*	stop_timer(T1) Phy_ABORT.req()	Stopped
M.Rec	*Phy_ABORT.ind(EP-1)*	DL_ABORT.ind(EL_3F)	M.Rec
M.Rec	*Phy_ABORT.ind(ErrorNb) &* *ErrorNb <> EP-1*	DL_ABORT.ind(ErrorNb)	Stopped
M.Rec	*exist_dl_physical_setup_req()*	Phy_SETUP(params)	M.Rec

Table 39 – Meaning of the states listed in the previous tables

State	Meaning
Initial	Initialization of the variables of the layer
Stopped	Waiting for the first request from the upper layer or for the first indication from the lower layer.
W.AG (Wait for end of " Wake-up Calll")	Waiting for the end of a "Wakeup Call" signal transmission
W.EndS (Wait for end of Session)	Waiting for the end of a session
T.Req (Test Request)	Testing the nature of a request coming from an upper layer
M.RSO (Must Receive RSO)	Waiting for responses from a call of forgotten stations
T.RSO (Test last RSO)	Testing the end of the last time slot for RSO frame reception
M.Send (Must Send)	Test state of the frame to transmit. (The field Text may be empty)
M.Rec (Must Receive)	Initial state of the receiver waiting for the first byte of a frame
T.Com (Test Command)	Testing the com field of a received frame
W.MM (Wait for Support Manager event)	Waiting to receive an event from the Support Manager layer

Table 40 – Definition of the procedures and functions classified in alphabetical order

Procedure or function	Definition
alarm_detection()	Check that Alarm mode is active
build_RSO(ListRSO, Frame)	Extraction of the RSO elements (TAB and ADS fields) from the received RSO frame Frame and concatenation with the preceding list ListRSO
check_address(Frame)	Check that the ADP and ADS addresses are recognized according to the following criteria: • DP is APG or the station has been programmed to the ADP address; • if the command code is ASO, IB or TRB, then ADS is ADG; • if the command code is not ASO, IB nor TRB, then ADS is the secondary station address
check_frame(Frame)	Check that the frame Frame received is correct: • number of bytes greater than or equal to 11 and lower than or equal to MaxIndex; • CRC correct; • number of bytes compatible with the field Size; • command code recognized and number of bytes compatible with the command code
com(DATA+, Pr, Send, Confirm)	Concatenation of corresponding binary fields to obtain a specific command
command(Frame)	Extraction of the value of the command code of a received frame Frame
concat(Size, ADS, ADP, COM, Text), or concat(Frame, CRC)	Concatenation of the fields Size, ADS, ADP, COM and Text or concatenation of the CRC at the end of the frame Frame
context(ADS, ADP, TypeAG)	Extraction of the corresponding values from the communication context
crc(Frame)	Calculation of the CRC of the frame Frame to send
create_alarm(TPDU)	Calculation of a TPDU with STSAP = 0, DTSAP = 0 and an UnsolictedReqPDU with: client-type = FFFF, serveridentifier = 0, object-name = FFFF variable type = boolean, value = TRUE
exist_dl_data-req(DL_DATA.req(Pr, DSDU))	Consumption of a DL_DATA.req(Pr, DSDU) event
exist_dl_req()	Check for the existence of a DL_IB.req(), DL_ASO.req(DSDU) or DL_DATA.req(Pr, DSDU) event and compatibility check with ADS and ADP adresses defined in the communication context
exist_dl_req(DL_IB.req()) or exist_dl_req(DL_ASO.req(DSDU))	Consumption of a DL_IB.req or DL_ASO.req(DSDU) event
exist_dl_physical_setup_req	Consumption of a baudrate reconfiguration event.
extract_ADP(Frame)	If either the ADP value used in the frame is not APG or if it is the APG value but the list of the ADP values to which the Secondary Station has been programmed is empty, then extraction of this value, otherwise extraction of the first ADP value to which the Secondary Station has been programmed
extract_prty(Frame)	Extraction of the Priority field from a received frame Frame
extract_text(Frame)	Extraction of the Text field from a received frame Frame
init(TypeAG)	Set Index to MaxRetry if TypeAG equals AGT, otherwise to 0
init_incrChain()	Set IncrChain at 0 if the alarms are not managed, otherwise to 1
init_timer(T1)	Setting of wakeup T1
initTimer(Req)	Initialisation of the waiting for a request from upper layers timer.
is_ack (Frame)	Check that the received frame Frame contains a Confirm field equal to the Send field of the last frame transmitted
is_data+ (Frame)	Check that the received frame Frame contains a correct DATA+ field("111"B)

Procedure or function	Definition
is_text(Frame)	Check that the received frame Frame contains a non-empty text field and that the Send field equals the 1' complement of theConfirm field of the last frame transmitted
size(Frame)	Calculation of the size of the frame Frame received
size_frame(DSDU)	Calculation of the size of the frame to build with the DSDU data unit (size(DSDU) + 11)
stop_timer(T1)	Stopping of wakeup T1
test_TABi(Frame, TAB)	If the first TABi contained in the received ASO frame Frame equals 00, check that Discovered=FALSE then, after provision of a whole random integer between 0 and 100, check that this integer is smaller than the response probability (second TABi). In this case, 00 is memorized in the TAB variable If the first TABi contained in the received ASO frame Frame equals FF, check that Flag_alarm=TRUE then, in this case, Flag_alarm is set to FALSE and FF is memorized in the TAB variable; If the first TABi contained in the received ASO frame Frame does not equal 00 or FF, check that FlagDSO=TRUE and check that the Secondary Station has been programmed to one of the TABi contained in the received ASO frame Frame. In this case, the first of these values is memorized in the TAB variable
time_out(T1)	Triggering of wakeup T1
TreqTimeout()	Verification that the waiting time of a request from upper layers does not exceed a time t so that the time out duration TOL managed by the physical layer might happen eventually. This waiting time is necessarily less than TOL and is armed once the indication is sent to the upper layer
window_RSO()	Provision of a whole random integer between 0 and MaxRSO-1 used as the number of the RSO time slot in which the station shall reply (refer to Annex F)

7.4 Support Manager layer

7.4.1 Overview

The Support Manager layer processes all services related to communication support. These services are:

- initialisation of the bus;
- discovery management;
- alarm management;
- speed negotiation.

These services are managed in such a way that they are consistent with their management under profiles with or without DLMS. For these services, the identifiers have the values as specified in Table 41.

Table 41 – Commands managed by the Support Manager layer

Identifier	Hexadecimal Value	Role	P/S
ASO	07	Discovery request	Primary Station
RSO	08	Discovery request response	Secondary Station
IB	09	Initialisation of the bus	Primary Station
XBR	0x12	Change Baudrate Request	Primary Station
XBA	0x13	Change Baudrate Answer	Secondary Station

7.4.2 Initialisation of the bus

Management complies with 4.4.6. Although the initialisation is managed by the Support manager layer, processing is entirely carried out by the Data link layer.

7.4.3 Discover service

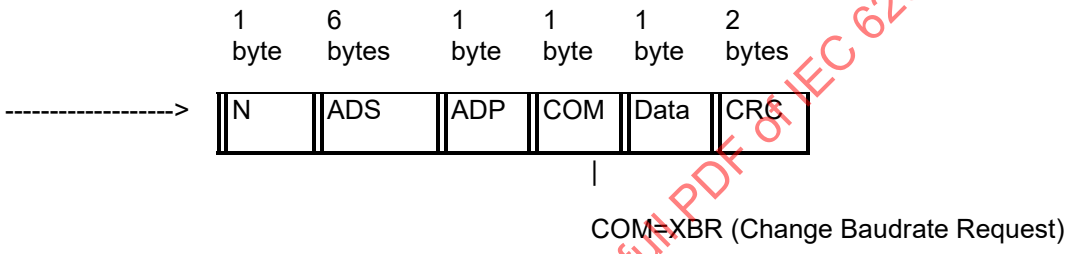
Management of the Discover service complies with 4.4.7 and Annex H. The TAB field contains 2 parameters of one byte each: the first has a value of 0, the value at which all equipment is programmed. The second is the probability of a response.

7.4.4 Speed negotiation

Once the connection at data link level is established, the Support Manager layers can negotiate the communication speed. This negotiation is always initiated by the primary device.

Authorised speeds are 1 200, 2 400, 4 800 and 9 600 bauds.

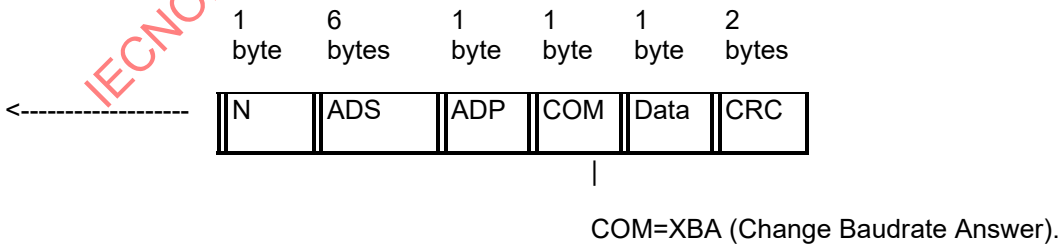
- Communication Speed Negotiation Frame



The Data field contains the speed at which the primary equipment wants to communicate. The values are as follows:

- 0x00 1 200 bauds,
- 0x01 2 400 bauds,
- 0x02 4 800 bauds,
- 0x03 9 600 bauds.

- Secondary station response frame:



The Data field contains the speed selected by the secondary station.

The primary station observes a TES delay of 50 ms at the end of the process in order to allow the two stations present to adjust the connected devices to the selected speed.

After a successful change of speed, the parameters as specified in Table 42 are modified.

Table 42 – List of parameters

Parameter	Old value	New value
Baudrate	1200 baud	Value Negotiated
MaxIndex	128	255
TOL	100 ms	1 000 ms
TA10	160 ms	1 100 ms

7.4.5 Support Manager parameters

For a primary station, the value of the maximum number of RSO timeslots for the processing of a ‘discover’ frame is set to 3.

7.4.6 State transitions

Support Manager layer state transitions are as specified in Table 43, Table 44, Table 45 and Table 46.

Table 43 – Support Manager layer state transitions: Primary Station

Initial State	Triggering Conditions	Set of actions	Final State
Stopped	Exist_req(discover)	TABi=0 DL_Discover.req()	M.Rec
Stopped	Exist_req(change_baud_rate)	Baudrate = proposed_baudrate DL_ChangeBaudrate.req()	M.Rec
Stopped	DL_abort.ind(ErrorNb)	T Abort.ind() Update(FatalError)	Stopped
Stopped	Exist_req(init_bus)	DL_InitBus_req()	Stopped
Stopped	Exist_req(abort)	DL_Abort.req()	Stopped
Stopped	DL_alarm.ind()	MM alarm.ind()	Stopped
M.Rec	Exist_cnf(discover)	MM discover.cnf(disc list)	Stopped
M.Rec	Exist_cnf(change_baud_rate) & check(proposed_baudrate)	Baud_rate = accepted_baudrate DL_PhysicalSetup.req(accepted_baudrate)	Stopped
M.Rec	Exist_cnf(change_baud_rate) not(check(received_baudrate))	$none	Stopped

Table 44 – Support Manager layer state transitions: Secondary Station

Initial State	Triggering Conditions	Set of actions	Final State
Stopped	exist_ind(DL_IB_ind)	MM_IB.ind()	Stopped
Stopped	exist_ind(discover) & test_TABi(TAB)	MM_Discover.cnf()	Stopped
Stopped	exist_ind(discover) & not(test_TABi(TAB)	MM_Discover.cnf(not_TABi)	Stopped
Stopped	exist_ind(dl_change_baud_rate) & check(proposed_baudrate) & not(energized_station)	accepted_baudrate =min(received_baudrate, programmed_baudrate) DL_SetupBaudrate.req(accepted_baudrate) Init_timer(TWS)	Sending
Stopped	exist_ind(dl_change_baud_rate) & not(check(received_baudrate))	DL_ABORT.req(Strong) T_ABORT.ind()	Stopped
Stopped	DL_abort.ind(ErrorNb)	T_ABORT.ind() Update(FatalError)	Stopped
Stopped	Alarm_detection() & DL_ALARM.req()	DL_ALARM.req()	Stopped
Sending	time_out(TWS)	DL_PhysicalSetup.req(accepted_baudrate)	Stopped

Table 45 – Meaning of the states listed in the previous table

State	Meaning
Stopped	Waiting state for a request or the first indication from the lower layer.
M.Rec	Waiting state for a response following the sending of a request
Sending	Waiting for the end of transmission from lower layers; This wait is limited by a timeout TWS with a value of 150 ms.

Table 46 – Definition of procedures, functions and events

State	Meaning
Alarm_detection()	Check that alarm mode is active
exist_ind(indication)	Check for the presence of a change of baudrate, IB or Discover indicator.
exist_ind(request)	Check for the presence of a baudrate change, IB or Discover request
Init_timer(TWS)	Initialisation of the TWS timer from the moment that the speed change request from the secondary station is sent by the lower layers.
check(received_baudrate)	Check that the received baudrate falls within the acceptable range.
min(received_baudrate, programmed_baudrate)	Determination of the accepted speed. This is the smallest value between the proposed value and the maximum at which the secondary equipment can function.
Test TABI(TAB)	If the first of the ASO TABi contained in the frame Frame has a value of 00, check that the Discovered variable is FALSE and verify, after generating a random number between 1 and 100, that this number is less than the probability of the response expected in the second TABi. In this case the value 00 is memorised in the TAB variable. If the first of the ASO TABi contained in the frame Frame has a value of FF, check that the Flag_alarm variable is TRUE, and in this case, allocation of the value False to the variable Flag_alarm and memorisation of the value FF in the TAB variable. All other values of TAB are not valid.

7.5 Transport Layer

7.5.1 General

The Transport layer is totally identical at the primary and secondary station. Its role is to ensure the fragmentation and reassembly of the application protocol data units.

In the transmission, the transport layer receives the application data units, fragments them into many transport data units as necessary in order to allow the Data Link layer to send them to the transport layer of the peer station.

In reception, Transport Data Units received by the Transport layer, when their size exceeds the link layer payload, are fragmented. The receiving Transport entity makes sure that the Transport units being received are complete before closing the reception.

The end of the reception is indicated by the End field to TRUE.

7.5.2 Transport Data Units

The structure of the first transport data unit is

3 bits	1 bit	1 bit	3 bits	8 bits	8 bits	N bytes
DSap	End	First	Reserved	STSAP	DTSAP	Payload

The structure of the Data units that follow is:

3 bits	1 bit	1 bit	3 bits	N bytes
DSap	End	First	Reserved	Payload

- The Dsap field comprises 3 bits. It identifies the data units under DLMS/COSEM. It has a value of 6;
- The End field indicates if the transport unit is the last. As long as the Application data unit is fragmented and the current transport data unit is not the last, its value stays as FALSE;
- The First field indicates if the Transport unit is the first or not. Whilst the first field is TRUE, the TPDU shall contain the source and destination adresses. All the transport units that follow are relative to the connection defined by STSAP and DTSAP carried on the first data unit, until the arrival of the transport unit with the End field. As long as the TPDU is the first and last, the two fields, End and first are both TRUE. A TPDU that does not contain a STSAP and DTSAP cannot have the field First as TRUE;
- The Reserved field comprises 3 bits which shall always be at 0;
- The STSAP field of 8 bits contains the address of the application layer data source;
- The DTSAP field of 8 bits contains the address of the application layer data destination;
- The payload field contains the application data. The first TSDU has a maximum size of 241 bytes and 243 for those that follow. Until the speed negotiation has taken place, the sizes are limited to 114 and 116 bytes respectively.

Transport layer services are specified in Table 47.

Table 47 – Transport services and services primitive

Service	Service primitive
T_DATA	T_DATA.req(STSAP, DTSAP, Pr, Service class, TSDU) T_DATA.ind(STSAP, DTSAP, Service Class, TSDU)
T_ABORT	T_ABORT.req() T_ABORT.ind()

- The primitive T_DATA.req(STSAP, DTSAP, Pr, Service class, TSDU) enables the *Application* layer to request the *Transport* layer to send a transport data unit from a source address STSAP to a destination address DTSAP with a priority Pr., using a confimed or unconfirmed service;
- The primitive T_DATA.ind(STSAP, DTSAP, Pr, Service class, TSDU) enables the *Transport* layer to inform the *Application* layer of the arrival of a transport data unit from a source address STSAP at a destination address DTSAP, transported with a confirmed or unconfirmed service;
- The primitive T_ABORT.req enables the *Application* layer to request the *Transport* layer to end its activity;
- The primitive T_ABORT.ind enables the *Transport* layer to inform the *Application* layer of an error necessitating an end to communication.

7.5.3 State transitions

Transport layer state transitions are as specified in Table 48, Table 49 and Table 50.

Table 48 – Transport state transitions

Initial State	Triggering conditions	Set of actions	Final State
stopped	$true	Init()	Idle
idle	T_DATA.req(STsap, Dtsap, TSDU, Service_class,)	SMsg = TSDU	M.FirstFgt
Idle	DL_DATA.ind(Pr, TPDU) & check_fgt(TPDU) & first_fgt(TPDU) & not(last_fgt(TPDU))	Tsap(TPDU, STsap, DTsap) initBuffer() updateBufferRec(TPDU)	Rec
Idle	DL_DATA.ind(Pr, Service_class, TPDU) & check_fgt(TPDU) & fisrt_fgt(TPDU) & last_sgt(TPDU) & isSizeOK ()	Tsap(TPDU, STsap, DTsap) initBuffer() updateBufferRec(TPDU) T_DATA.ind(TPDU, STsap, DTsap)	Idle
Idle	DL_DATA.ind(Pr, Service_class, TPDU) & check_fgt(TPDU) & fisrt_fgt(TPDU) & last_sgt(TPDU) & not(isSizeOK())	Tsap(TPDU, STsap, DTsap) initBuffer() T_DATA.ind(TPDU, STsap, DTsap Service_class,)	Idle
Idle	DL_DATA.ind(Pr, Service_class, TPDU) & not(check_fgt(TPDU)	DL_ABORT.req() T_ABORT.ind()	*stopped*
Idle	DL_DATA.ind(Pr, Service_class, TPDU) & check_fgt(TPDU) & not(fisrt_fgt(TPDU)) & last_sgt(TPDU))	initBuffer() T_DATA.ind(TPDU, STsap, DTsap Service_class,)	Idle
Idle	T_ABORT.req()	DL_ABORT.req()	*stopped*
Idle	DL_ABORT.ind(ErrorNb)	T_ABORT.ind()	*stopped*

Initial State	Triggering conditions	Set of actions	Final State
M. FirstFgt	Size(SMsg)>FirstPayload()	End=0 First=1 DL_DATA.req(DSap,End, STsap, DTsap, Service_class, FirstPayload()) update(SMsg)	M.NextFgt
M. FirstFgt	Size(SMsg)<=FirstPayload()	End=1 First=1 DL_DATA.req(DSap,End, STsap, DTsap, Service_class, FirstPayload())	Idle
M.FirstFgt	DL_ABORT.ind(ErrorNb)	T_ABORT.ind()	*stopped*
M.NextFgt	Size(SMsg)>NextPayload()	End=0 First=0 DL_DATA.req(DSap,End, STsap, Service_class, min(SMsg, NextPayload())) update(SMsg)	M.NextFgt
M.NextFgt	Size(SMsg)<=NextPayload()	End=1 First=0 DL_DATA.req(DSap,End, STsap, Service_class, NextPayload())	Idle
M.NextFgt	DL_ABORT.ind(ErrorNb)	T_ABORT.ind()	*stopped*
Rec	DL_DATA.ind(Pr, Service_class, TPDU) & not(check_fgt(TPDU))	initBuffer() T_DATA.ind(TPDU, STsap, DTsap, Service_class,)	Idle
Rec	DL_DATA.ind(Pr, Service_class, TPDU) & check_fgt(TPDU) & not(fisrt_fgt(TPDU)) & not(last_fgt(TPDU))) & isSizeOK ()	Tsdu(TPDU) updateBufferRec(TPDU) DL_DATA.req(DSap,End, STsap, DTsap, Service_class, text=NULL)	Rec
Rec	DL_DATA.ind(Pr, Service_class, TPDU) & check_fgt(TPDU) & not(fisrt_fgt(TPDU)) & not(last_fgt(TPDU)) & not(isSizeOK ())	Tsap(TPDU, STsap, DTsap) InitBuffer () T_DATA.ind(STsap, DTsap, Service_class, TPDU)	Idle
Rec	DL_DATA.ind(Pr, Service_class, TPDU) & check_fgt(TPDU) & not(fisrt_fgt(TPDU)) & last_fg(TPDU)) & isSizeOK	Tsdu(TPDU) updateBufferRec (TPDU) T_DATA.ind(STsap, DTsap, Service_class, TPDU)	Idle
Rec	DL_DATA.ind(Pr, Service_class, TPDU) & check_fgt(TPDU) & not(fisrt_fgt(TPDU)) & last_fg(TPDU) & not(isSizeOK ())	Tsap(TPDU, STsap, DTsap) InitBuffer () T_DATA.ind(STsap, DTsap, Service_class, TPDU)	Idle
Rec	DL_DATA.ind(Pr, Service_class, TPDU) & check_fgt(TPDU) & first_fgt(TPDU) & not(last_fgt(TPDU)))) & isSizeOK ()	Tsap(TPDU, STsap, DTsap) InitBuffer () updateBufferRec(TPDU) DL_DATA.req(DSap,End, STsap, DTsap, Service_class, text=NULL)	Rec
Rec	DL_DATA.ind(Pr, Service_class, TPDU) & check_fgt(TPDU) & first_fgt(TPDU) & not(last_fgt(TPDU)))) & not(isSizeOK ())	Tsap(TPDU, STsap, DTsap) InitBuffer () T_DATA.ind(STsap, DTsap, Service_class, TPDU)	Idle

Initial State	Triggering conditions	Set of actions	Final State
Rec	DL_DATA.ind(Pr, Service_class, TPDU), & check_fgt(TPDU) & first_fgt(TPDU) & last_fgt(TPDU) & isSizeOK ()	Tsap(TPDU, STsap, DTsap) InitBuffer () updateBufferRec(TPDU) T_DATA.ind(STsap, DTsap, Service_class, TPDU)	Idle
Rec	DL_DATA.ind(Pr, Service_class, TPDU), & check_fgt(TPDU) & first_fgt(TPDU) & last_fgt(TPDU) & not(isSizeOK())	Tsap(TPDU, STsap, DTsap) InitBuffer () T_DATA.ind(STsap, DTsap, Service_class, TPDU)	Idle
Rec	DL_ABORT.ind(ErrorNb)	T_ABORT.ind()	*stopped*

Table 49 – Meaning of the states listed in the previous table

State	Meaning
Stopped	Stopped
Idle	Waiting state for a request from the application layer or an indication from the Data Link Layer
M.FirstFgt (Must first Fragment)	Initial transmission state with fragmentation of the application data unit
M.NextFgt (Must next Fragment)	Transmission state with fragmentation of the application data unit for the following fragments
Rec	Reception state with fragmentation of the received data units

Table 50 – Definition of the procedures and functions classified in alphabetical order

Procedure or Function	Definition
check_fgt(TPDU)	Check that the TPDU or TSDU carry the indentifier Dsap=6
first_fgt(TPDU)	Check if the fragment is the first or not. The first fragment shall have the fields DTSAP and STSAP correctly set and the field First = TRUE
FirstPayload()	Determination of the FirstPayload size. This determination invokes the Support Manager layer which returns back the value 114 or 241 depending whether the speed negotiation took place or not.
init()	Initialization of state chart
initBuffer(TPDU)	Processing related to a first fragment The initial value of the APDU descriptor points to the top of the buffer, and the size of receivable data is equal to the size of the APDU. These parameters are provided by the Application layer.
IsSizeOK()	Check that the dat unit size is not greater than the available memory at the destination.
last_fgt(TPDU)	Check if the fragment is the last or not. The last fragment always has the field END= TRUE
min(SMsg, Payload)	Takes into account the size of the smallest of two parameters.
NextPayload()	Determination of the NextPayload size. This determination invokes the Support Manager layer which returns back the value 116 or 243 depending whether the speed negociation takes place or not.
Size(SMsg)	Calculate the size of the message SMsg in bytes
tsap(TPDU, STsap, DTsap)	Extraction of the fields STSAP and DTSAP of the TPDU
tsap(TPDU)	Extraction of the data fields of the TPDU

Procedure or Function	Definition
UpdateBufferRec(TPDU)	Update of the received Data buffer: Transfer of the TPDU data received into the Application buffer without exceeding the maximum size of the APDU; then the pointer describing the buffer, and the total length of the data received are increased accordingly. If the size of the data received exceeds the available buffer size, the buffer is reinitialised and the upper layer is informed of reception with an empty buffer.
Update(SMsg)	Update of the APDU after the transmission of a TPDU. The descriptor of the APDU is increased by the number of bytes sent and the length is reduced by the same amount.

7.6 Application Layer

7.6.1 General

The specification of the Application layer can be found in IEC 62056-5-3. However, given the nature of the medium used and the characteristics of the lower layers, the following restrictions and behaviour apply.

7.6.2 Broadcast Management

All exchanges use confirmed services by default. Only broadcasting uses unconfirmed services. Broadcasting can only be used by a primary station. The type of service used will be propagated from the Application layer to the Data Link layer, which, depending on the service type specified, will use a specific destination address if the service type is confirmed or a broadcast address if the service type is unconfirmed.

The secondary station shall not respond to requests carried by an unconfirmed service. This lack of response is managed by the application layer depending on the type of service.

Broadcasting will always be done without a speed negotiation, that is, at 1 200 bauds, with a data size of 114 bytes at the application layer level.

7.6.3 Management of EventNotifications or InformationReports

Secondary stations cannot transmit on the bus without having been requested. Management of event notifications or information reports is done in Euridis with the use of an alarm. The primary station is responsible for engaging the necessary actions to interrogate the equipment generating an alarm.

7.6.4 Priority Management

In the Euridis profile, priority management occurs at the Data Link layer. The DLMS/COSEM Application layer also has priority management tools. The DLMS/COSEM layer tools take precedence over those of Euridis for greater homogenisation.

However, in order to maintain compatibility with the DLMS profile, the priority management field (Pr) is maintained up to the Transport level. The transport layer simply ignores it in its relation with the application layer.

7.6.5 Management of releasing Application Associations

DLMS/COSEM Application Associations can be active only as long as the supporting layer of the DLMS/COSEM Application Layer is active. The Association is terminated when the activities of the lower layers are terminated.

Application Associations can be released either by closing the supporting layer or by using the RLRQ / RLRE services.

Note that if an Application Association is released by using the RLRQ / RLRE services, this does not affect the supporting layer.

8 Local bus data exchange – Hardware

8.1 General

The protocol describes the data exchanges between a Primary Station and Secondary Stations connected in parallel on a hardware bus. The Primary Station is connected to the bus by a passive magnetic plug.

This clause describes the following items:

a) the signal characteristics;
b) the bus characteristics;
c) the magnetic plug;
d) the Primary Station;
e) the Secondary Station;
f) the energy supply characteristics.

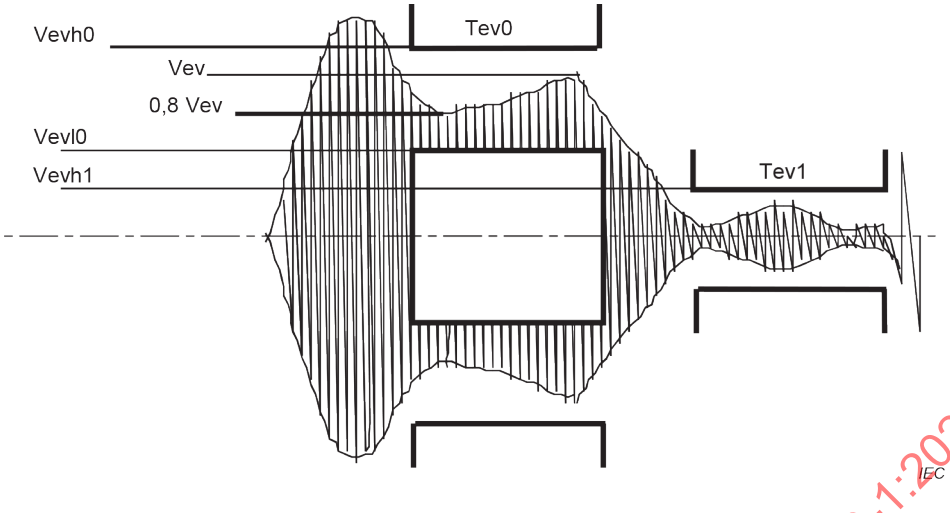
8.2 General characteristics

8.2.1 Signal transmission at 50 kHz

Transmission includes:

a) binary data transmission;
b) bi-directional, half-duplex;
c) baud rate: 1 200 Bd ± 1 %, 2 400 Bd ± 1 %, 4 800 Bd ± 1 %, 9 600 Bd ± 1 %;
d) equal duration of bits 0 and 1;
e) amplitude signal modulation (ASM) of a 50 kHz ± 3 % carrier;
f) polarity:
   - 0 = carrier detected;
   - 1 = carrier not detected

The signal characteristics are defined by the carrier envelope described in Figure 6.



Key

Vevh1 is the maximum level for transmission of a "1"

Vevl0 is the minimum level for transmission of a "0"

Vevh0 is the maximum level for transmission of a "0"

Tev1 is the minimum guaranteed time for an envelope to remain lower than Vevh1

Tev0 is the minimum guaranteed time for an envelope to remain between Vevl0 and Vevh0

Figure 6 – Signal envelope on the bus

g) Vevl0 and Vevh0 are not the extremes of the envelope, but rather the low and high limits for correct operation;

h) during Tev0 the level of the envelope shall not vary by more than 20 %;

i) during the gaps between Tev0 and Tev1, the envelope rise or fall is exponential or damped sinusoid, with addition of frequency transients;

j) total harmonic distortion of the signal during continuous wave transmission is less than 15 %, with a resistor of 100 Ω or a capacitor of 31,8 nF in place of the bus;

k) all the voltages are specified in peak values;

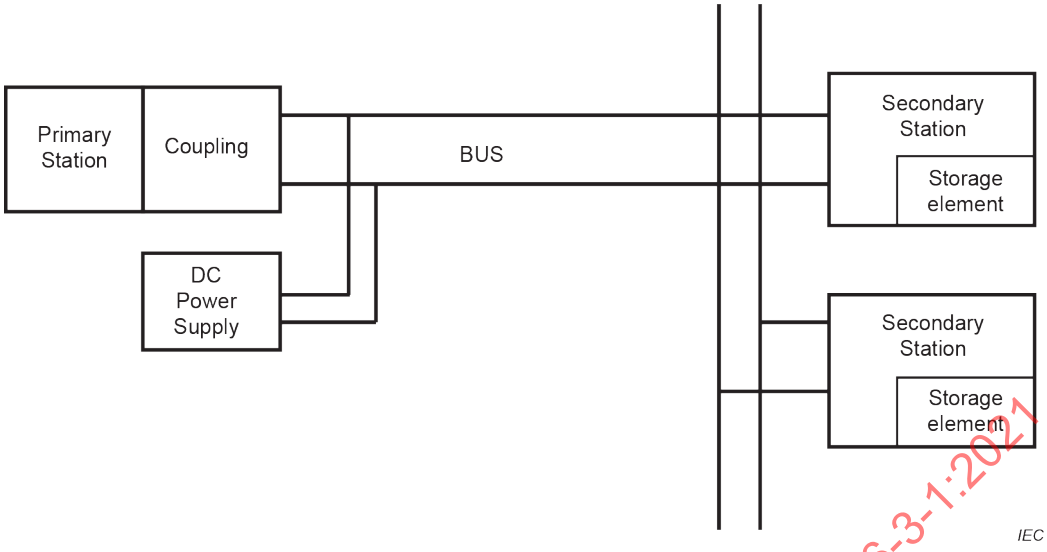
l) for Time Bit definition (time of "1" or "0"), several parameters have to be taken into account:

- maximum time guaranteed for "0" transmission signal ≥ Vevl0;
- maximum time non-guaranteed for "0" transmission signal ≥ Vevh1;
- maximum time guaranteed for "1" transmission signal ≤ Vevh1;
- maximum time non-guaranteed for "1" transmission signal ≤ Vevl0.

8.2.2 Energy supply signal transmission

8.2.2.1 Characterization of the remote supply of energy

Figure 7 gives the representation of the bus for the remote supply of energy.



NOTE External DC power supply is optional. Supply DC power can be integrated inside Primary Station.

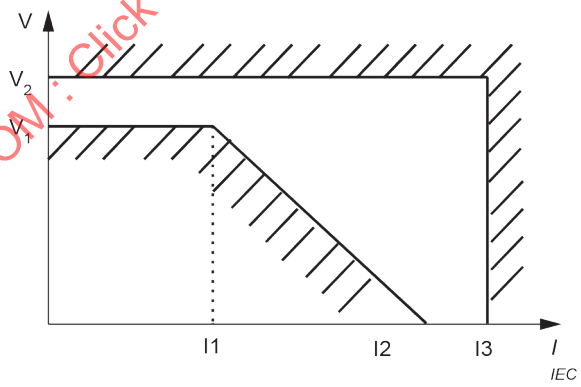
Figure 7 – Bus representation

The three main elements for the remote supply of energy are:

a) a DC energy supply source,
b) a storage element in the Secondary Station,
c) the consumption of a Secondary Station.

8.2.2.2 Energy supply source

The energy supply source provides the bus with the values of voltage and current according to the template of Figure 8.



Key

V1 = 22 V, V2 = 35 V

I1 = 80 mA, I2 = 250 mA, 350 mA ≤ I3 ≤ 1 000 mA

Figure 8 – Power supply characteristics

The ripple noise will be less than 10 mV peak from 1 kHz to 1 MHz and 100 mV peak for f < 1 kHz.

The nature of the energy supply is not taken in account in this specification.

8.2.2.3 Storage Element in Secondary Station

A storage element associated with each Secondary Station allows the local accumulation of energy in order to absorb peaks of consumption during exchanges and to optimize the remote energy supply source. (Maximum value of 470 µF with a relative tolerance of + 20 %.)

8.2.2.4 Consumption of a Secondary Station

States associated to an exchange session are shown in Figure 9 and Figure 10.

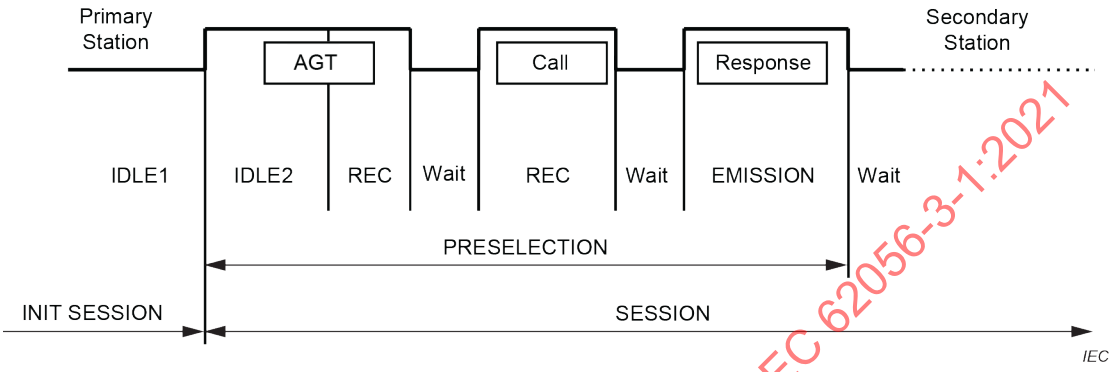


Figure 9 – States associated to a session: for selected Secondary Station

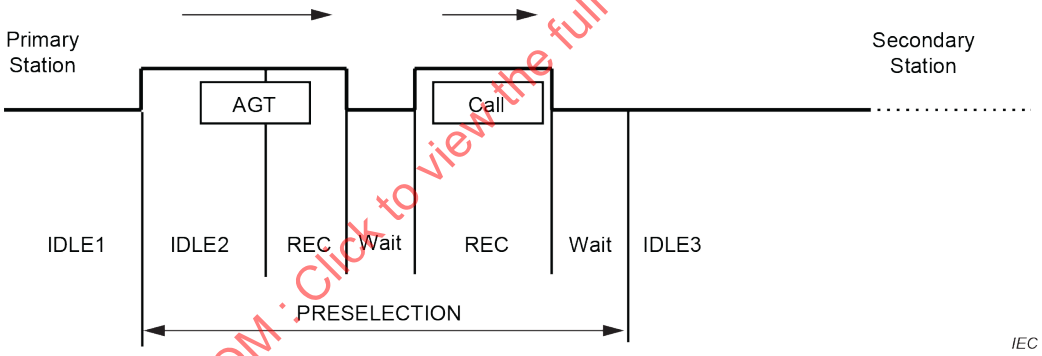


Figure 10 – States associated to a session: for non-selected Secondary Station

The consumption, depending on the states, is specified below.

These values represent maximum average consumption: peak can go over but average value remains under:

- Idle mode 1 15 mW max. (established mode);
- Idle mode 2 15 mW max.;
- Idle mode 3 15 mW max.;
- Reception mode 40 mW max. + nx10 mW max. (n = number of devices), see note;
- Wait mode 40 mW max. + nx10 mW max. (n = number of devices);
- Emission state 140 mW max. + nx10 mW max. (n = number of devices), see note.

Worst case is the transmission of 9/10 "0" bits:

- Reception mode 50 mW max. + nx14 mW max. (n = number of devices); see note;
- Emission state 180 mW max. + nx14 mW max. (n = number of devices) see note.

The detailed description of these different modes (with the associated timing) is given in the state transitions.

NOTE Reception and Emission consumption depends on the message content number of "0". Those values are average consumptions with an equal number of "0" and "1" bits.

8.2.3 Simple Secondary Station and multiple Secondary Station

A simple Secondary Station is equivalent to a logical address ADS.

A multiple Secondary Station is equivalent to several logical addresses ADS.

The notion of multiple Secondary Station, see Figure 11, allows the addressing of different devices located inside a Secondary Station on a secondary bus.

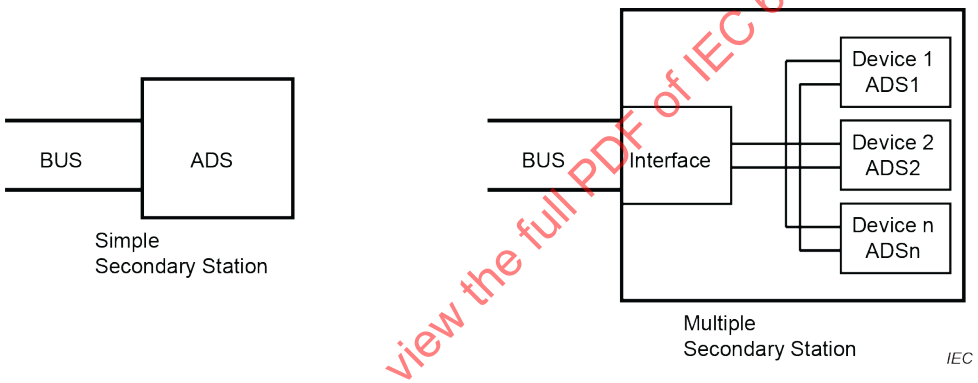


Figure 11 – Simple and multiple Secondary stations

The secondary bus structure fundamental points are as follows:

a) the length of secondary bus is not included in the length of main bus;

b) the secondary bus is four wires with two wires dedicated to signal and two wires dedicated to energy supply;

c) a Secondary non-energized Station, simple or multiple, is always equivalent to a maximum of two Secondary Stations towards physical communication parameters;

d) the primary and secondary bus protocol are the same, except for modulation aspects: signals on secondary bus are baseband (1 200 Bd to 9 600 Bd): signal wires. They are in accordance with EIA 485 and with ISO/IEC 8482;

e) the maximum length of the secondary bus is 50 m;

f) the maximum number of devices on the secondary bus is 6;

g) the cable is the same as the one used on the primary bus;

h) it is possible to transmit alarms from a device to a primary station through the interface, when power supply is permanent on this bus. This report is made by carrier transmission TAB. The primary station, the interface and the devices shall be in Alarm mode active (see 4.4.12).

Main bus is able to support the following stations:

1) Simple energized Secondary Station;
2) Simple non-energized Secondary Station;
3) Multiple non-energized Secondary Station.

8.3 Bus specification

8.3.1 General characteristics

a) Specific support for remote reading and programming. The bus always has a magnetic socket and one Secondary Station (minimum);

b) The bus topology is unimportant, and can be linear, or star or tree without loop, provided that the total wired length of cable does not exceed 500 m (cable of power supply included). The secondary bus, inside a Secondary Station, is not included in this value;

c) The bus allows energy supply for Secondary Stations. In this way, the bus can support energized and non-energized stations;

d) Galvanic isolation is maintained between the bus and all the electronics of the transmitters and receivers, with voltage ratings which are required in the standards applied to Secondary Stations;

e) Supply can be permanent on the bus, in which case Alarm mode can be active;

f) From 1 to 100 Secondary Stations can be connected in parallel on the bus:

   – The maximum number of non-energized Secondary Stations (simple or multiple) on the bus is 50;

   – The maximum number of energized Secondary Stations on the bus is 100;

   – The maximum number of devices associated to Secondary Stations (simple or multiple) on the bus is 50;

   – In case of a mix of Secondary Station types, Energized and non-energized, connected on a same bus, a rule gives the maximum number of each type:

      - if $N1$ is the number of non-energized multiple Secondary Stations on the bus;
      - if $N2$ is the number of non-energized simple Secondary Stations on the bus;
      - if $N3$ is the number of energized Secondary Stations on the bus, then these inequations have to be respected:

         1) $2*(N1 + N2) + N3 \leq 100$ when power supply is integrated to the Primary Station;

         2) $2*(N1 + N2) + N3 \leq 98$ when power supply is external, connected directly on the bus

g) one of these Secondary Stations can accidentally stay in low impedance (transmission mode but without emission of "0" transmission), without interrupting the communication;

h) communication with the Primary Station is via a magnetic plug (one only);

i) the bus shall withstand the accidental connection of the 230 V mains. Control procedure is to apply five times successively 250 V AC. Each application lasts 5 min and 5 s between each application.

8.3.2 Cable characteristics

Indoor telephone cable of type:

- single twisted pair and screen (aluminum) with drain wire;
- conductor: solid tinned copper of 0,5 mm to 0,6 mm nominal diameter;
- insulation PVC.

Electrical characteristics:

- DC looped resistance at 20 °C: 117 Ω/km to 192 Ω/km
- AC 50 kHz, between -15 °C to +45 °C:
  a) linear looped resistance: 154 Ω/km to 220 Ω/km;
  b) linear looped inductivity: 500 µH/km to 800 µH/km;
  c) linear mutual capacity: 80 nF/km to 130 nF/km;
  d) loss factor of capacity: 5 % maximum;
  e) capacity unbalance, wires to screen: 5 % maximum;
  f) complex characteristic impedance: 74 Ω to 115 Ω;
  g) linear phase shift (50 kHz): 150°/km maximum.

The above characteristics are given for a symmetric source isolated from screen with the impedances Z and Z' greater than 1 000 Ω at 50 kHz (Figure 12).

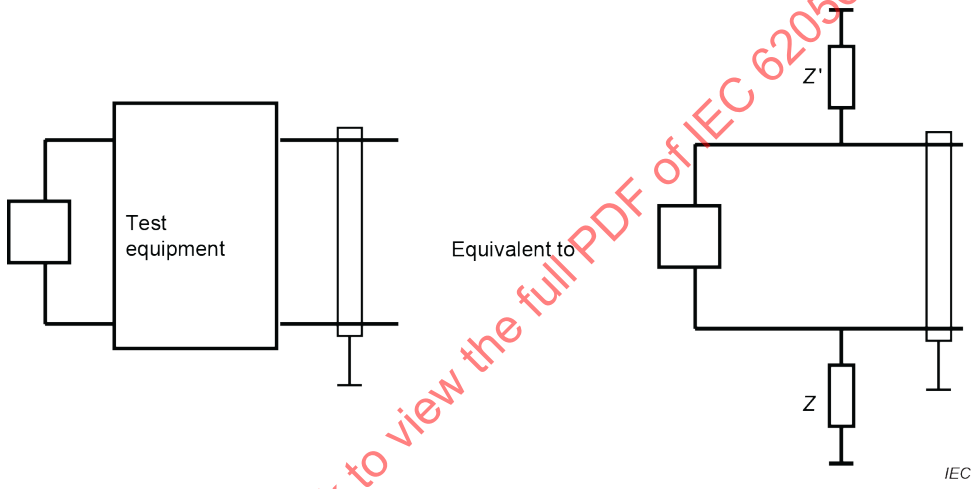


Figure 12 – Equivalent diagram of the test equipment

8.3.3 Wiring

a) connection of Secondary Stations shall ensure the continuity of the drain wire (e.g. three terminal distribution boxes);

b) one point of the drain wire shall be connected to earth, if any, or to an equivalent reference potential;

c) no impedance (except the cable), of less than 1 000 Ω at 50 kHz, shall be connected between wires of the bus and screen or earth.

For use of cables slightly outside the above specifications, the following should be noted:

– A cable with a higher linear capacity or resistance needs a lower length of wired cable. Ratio of length is approximately as the inverse ratio of linear capacity or resistance.

– A cable with a lower linear capacity or resistance could give overvoltage on receiver inputs for a long empty bus. This can be overcome by connecting between the wires of the bus, near the end opposite the magnetic plug, a damping resistor (330 Ω to 1 000 Ω, 0,25 W, depending on the overvoltage ratio). To ensure that the bus withstands an accidental connection to 230 V mains, a 47 nF capacitor of proper voltage capability should be in series with this resistor.

8.4 Magnetic plug

8.4.1 Function

8.4.1.1 Simple magnetic plug

The magnetic plug consists of a mobile plug (primary) and a fixed socket (secondary).

When the two halves are joined, the magnetic plug transfers signals between the HHU connected to the plug and the bus connected to the socket, in both directions.

Each part consists of half a ferrite transformer with an air-gap in the magnetic circuit.

To compensate the high series inductance and the low parallel inductance of such a transformer, a resonating capacitor and a damping resistor on both sides convert this transformer into a fourth order band-pass filter centered near 50 kHz, with a *Q* factor <3.

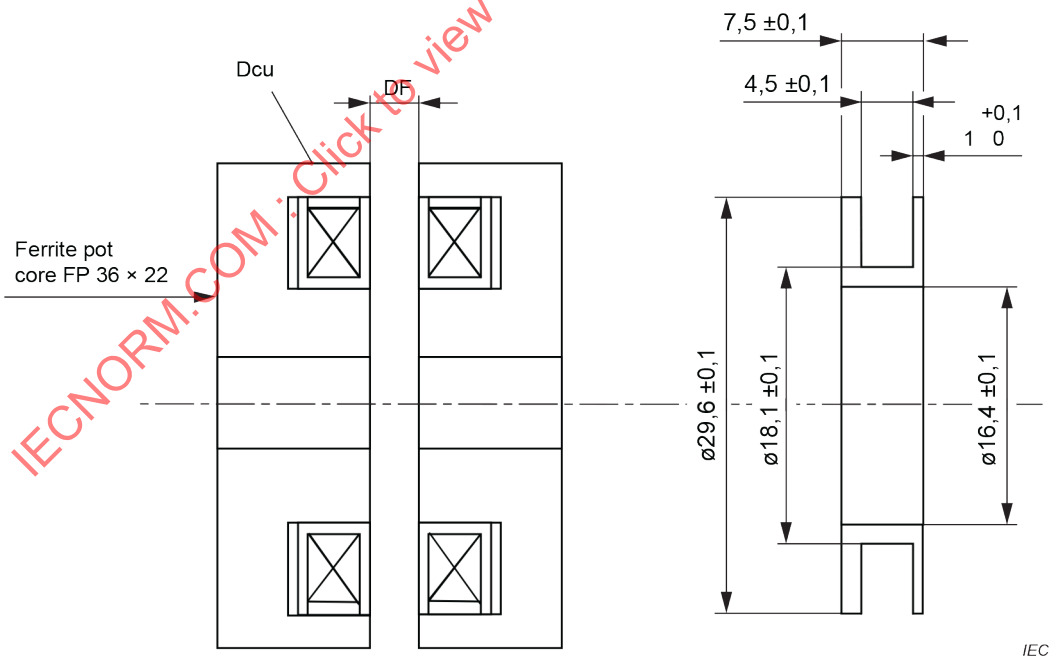
This allows the use of a simple square wave source for the transmission and eliminates the frequency transients.

8.4.1.2 Magnetic plug with energy supply

In addition to the previous characteristics, the magnetic plug with energy supply allows the transmission between 400 kHz and 600 kHz signal. The default value is fixed at 500 kHz. This signal is rectified and filtered before injection of d.c. signal on the bus.

8.4.2 Common mechanical characteristics

Dimensions in millimetres



Key

FP ferromagnetic pot

DF distance between ferrites

Dcu diametre of core unit

Figure 13 – Ferrite pot and bobbin

Each half of the magnetic plug comprises a bobbin in a half pot ferrite core, enclosed in a robust plastic housing, see Figure 13. When joined, the bobbins and ferrite cores are nearly coaxial and symmetric about the mid plane, with:

- magnetic air gap DF = 4,25 mm ± 0,25 mm;
- maximum error of coaxiality, near mid point: 0,25 mm.

When assembled and joined, both ferrite cores and bobbins shall be fixed or pushed closer to the mid plane. For example, the axial gap between bobbin and core, due to tolerances or sizes shall be at the rear side of the bobbin.

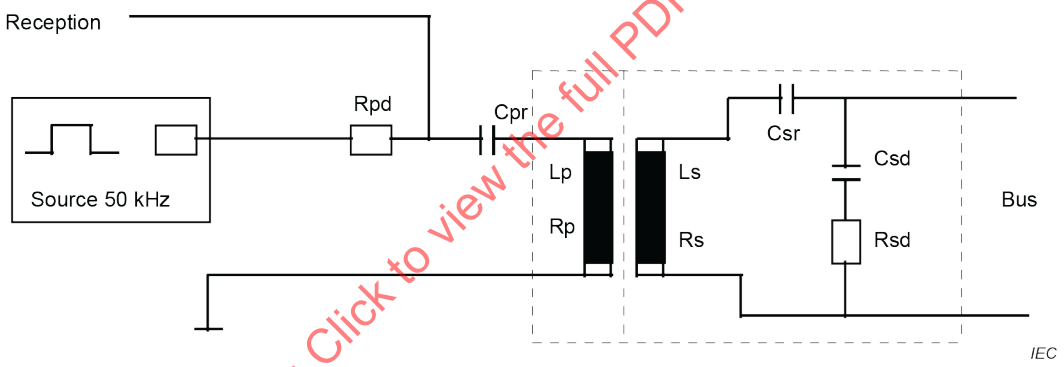
Ferrite is a standard type for a maximum frequency of less than 100 kHz:

- Initial permeability more than 1 800;
- Tan delta maximum at 100 kHz about 2 %;
- No saturation due to leakage fields (practically saturation comes around 0,4 T).

8.4.3 Electrical block diagram with simple plug

8.4.3.1 General

The general electrical bloc diagram with simple plug is shown in Figure 14, with its associatied components.



Key

Rpd	primary damping resistor	Lp	primary inductance
Cpr	primary resonance capacitor	Ls	secondary inductance
Csr	secondary resonance capacitor	Rp	primary resistance
Csd	secondary damping capacitor	Rs	secondary resistance
Rsd	secondary damping resistor		

Figure 14 – Associated components of the magnetic plug

8.4.3.2 Associated components in socket, bus side

Serial capacitor Csr resonating with Ls.

Parallel damping resistor Rsd.

Parallel capacitor Csd in series with Rsd to ensure immunity to accidental connection to 230 V mains.

8.4.3.3 Associated components, plug side

Serial capacitor Cpr resonating with Lp.

Serial damping resistor Rpd: (depending on the 50 kHz source, and including all series resistances (at 50 kHz), such as flexible cord, connector, etc.).

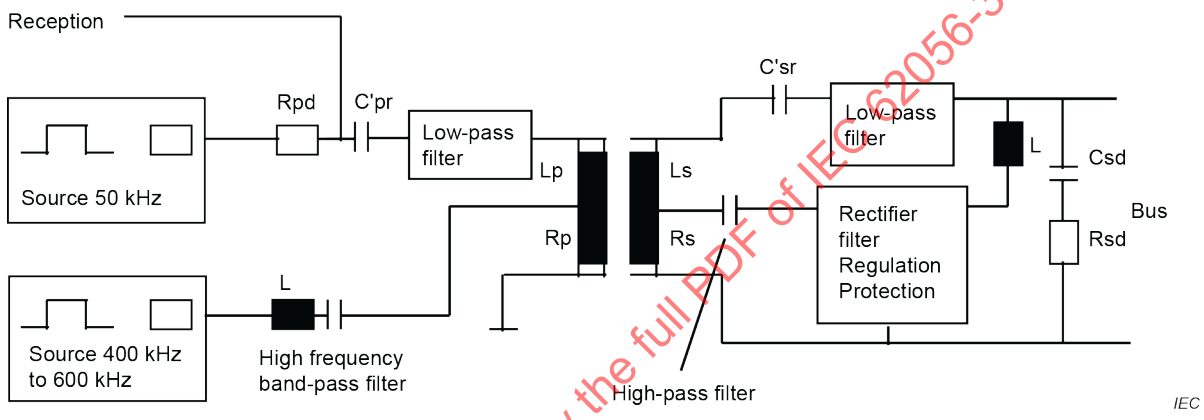
A 50 kHz source which can be a square-wave source.

Receiver circuit, demodulation and squaring, connected to the Cpr Rpd node (e.g. full wave rectifier and threshold circuit).

In receiving mode, the output impedance of the 50 kHz source shall be maintained at less than a few ohms, even for low voltage, to ensure damping of the primary circuit.

8.4.4 Electrical Block Diagram with energy supply plug

The electrical block diagram with energy supply plug, 8.4.1.2 is shown in Figure 15, with its associatied components.



Key

Rpd	primary damping resistor	Lp	primary inductance
C'pr	primary resonance capacitor	Ls	secondary inductance
C'sr	secondary resonance capacitor	Rp	primary resistance
Csd	secondary damping capacitor	Rs	secondary resistance
Rsd	secondary damping resistor		

Figure 15 – Associated components of the energy supply plug

The 50 kHz part works like the simple plug circuit, except for:

- extra attenuation, both ways, due to the low-pass filters. The 50 kHz source receiver device shall take this attentuation into account.
- C'pr and C'sr differ slightly from Cpr and Csr due to the low-pass filter impedance at 50 kHz.

The 400 kHz-600 kHz part provides means for the remote supply.

8.5 Functional specifications of Primary Station transmitter (for 50 kHz signal)

The Primary Station transmitter is the assembly of a Primary Station transmitting source and the magnetic plug.

The signal transmitted at the bus outputs shall fit into the limits (see Figure 6), of the whole temperature range, with:

a) Tev0 and Tev1 shall comply with the values Table 51.

Table 51 – Primary station transmitter: Tev0 and Tev1 values

	1 200 bauds	2 400 bauds	4 800 bauds	9 600 bauds
Tev1(µs)	750	330	140	60
Tev0(µs)	750	330	140	60

b) Vevh1 = 0,25 V

This concerns only signals with frequency 1 kHz ≤ *f* ≤ 1 MHz.

Open circuit at bus output:

c) Vevl0 = 5,8 V;

d) Vevh0 = 7,5 V.

With a resistor of 100 Ω in place of the bus:

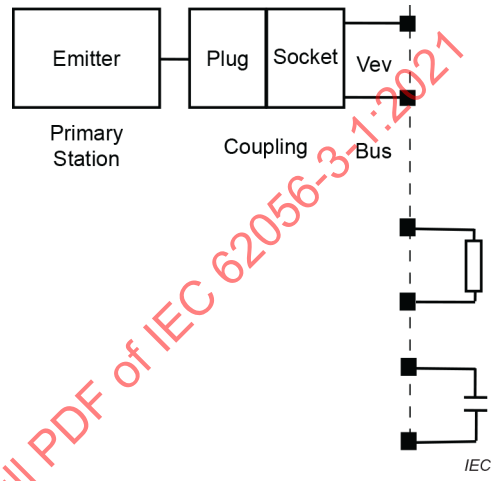
e) Vevl0 = 4 V;

f) Vevh0 = 4,8 V.

With a capacity of 31,8 nF in place of the bus:

g) Vevl0 = 5,2 V;

h) Vevh0 = 6,5 V.



In addition, the output terminals should be open-circuit or matched to a 100 Ω resistance or a capacitance of 31,8 nF.

i) the noise transmitted at the bus output, in all conditions and at all frequencies up to 1 MHz, after extinction of transients, shall not exceed 10 mV peak between 1 kHz and 1 MHz;

j) the overvoltage spike due to the switch from transmission mode to reception mode, or the reverse, shall not exceed 0,25 V peak, in all conditions.

These values have to be respected with a magnetic air gap
DF = (4,25 mm ± 0,25 mm) ± $^{0,15}_{0}$ mm.

8.6 Functional specifications of Primary Station receiver (for 50 kHz signal)

The Primary Station receiver is the assembly of a Primary Station receiving circuit (demodulation and squaring) and the magnetic plug.

The receiver shall function correctly (defined as frame repetition rate < 10^{-5}) for a sinusoidal input signal whose characteristics are defined above and for the complete temperature range.

The signal shall be applied to the bus terminals of the magnetic plug through the serial impedances given below:

a) Tev0 and Tev1 shall comply with the values Table 52.

Table 52 – Primary station receiver: Tev0 and Tev1 values

	1 200 bauds	2 400 bauds	4 800 bauds	9 600 bauds
Tev1(µs)	700	290	125	50
Tev0(µs)	700	290	125	50

Through a 100 Ω resistance:

b) Vevh1 = 0,25 V;

c) Vevl0 = 0,7 V,

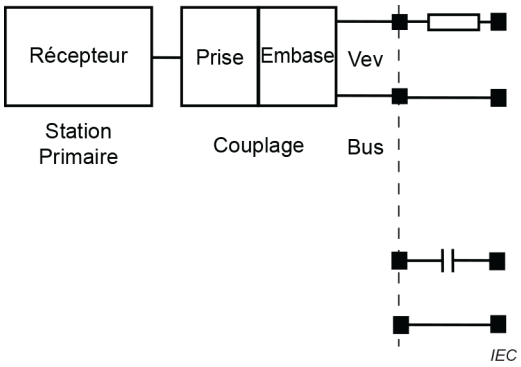
d) Vevh0 = 3,2 V.

Through 31,8 nF:

e) Vevh1 = 0,20 V;

f) Vevl0 = 0,55 V;

g) Vevh0 = 2,5 V.



In addition, the receiver in condition b) (100 Ω in series) shall function correctly (defined as frame repetition rate < 10^{-5}) with:

h) a continuous wave signal of 0,1 V peak from 1 kHz to 1 MHz;

i) a square pulse of 20 V of duration 5 µs;

j) a square pulse of 3,5 V of duration 200 µs.

8.7 Functional specification of Secondary Station transmitter (for 50 kHz signal)

The signal transmitted at the bus outputs shall fit into the limits specified, in the whole temperature range with:

a) Tev0 and Tev1 shall comply with the values Table 53.

Table 53 – Secondary station transmitter: Tev0 and Tev1 values

	1 200 bauds	2 400 bauds	4 800 bauds	9 600 bauds
Tev1(µs)	750	330	140	60
Tev0(µs)	750	330	140	60

b) Vevh1 = 0,1 V.

This only concerns signals with a frequency of 1 kHz ≤ *f* ≤ 1 MHz.

With 100 Ω in place of the bus:

c) Vevl0 = 1,2 V;

d) Vevh0 = 1,8 V.

With a capacitor of 31,8 nF in place of the bus, the output signal measured across a resistor of 1 Ω in series with the capacitor, and the result multiplied by 100:

e) Vevl0 = 1,5 V;

f) Vevh0 = 2,5 V.

In addition, with the two bus terminals connected to a resistance of 100 Ω or a capacitance of 31,8 nF:

g) the overvoltage spike due to the switching from transmission mode to reception mode, or the reverse, shall not exceed 0,75 V peak, in all conditions;

h) the noise transmitted at the bus output, in all conditions and at all frequencies up to 1 MHz, after settling of transients, shall not exceed 10 mV peak between 1 kHz and 1 MHz.

In addition:

i) maximum short circuit current: 26 mA peak at 50 kHz;

j) the transmitter shall tolerate permanent short circuit and connection to 230 V mains at the bus terminals;

k) the maximum common mode capacity between bus inputs and other inputs of the device including the secondary station is fixed to 15 pF.

8.8 Functional specifications of Secondary Station receiver (for 50 kHz signal)

The receiver shall function correctly (defined as bit error rate < 10^{-5}) for a sinusoidal input signal whose characteristics are defined above and for the whole temperature range with:

a) Tev0 and Tev1 shall comply with the values Table 54.

Table 54 – Secondary station receiver: Tev0 and Tev1 values

	1 200 bauds	2 400 bauds	4 800 bauds	9 600 bauds
Tev1(µs)	700	290	125	50
Tev0(µs)	700	290	125	50

With a voltage generator with negligible internal impedance, in comparison with input impedance of the receiver:

b) Vevh1 = 0,3 V;

c) Vevl0 = 2 V;

d) Vevh0 = 8 V.

In addition, the receiver shall be insensitive to:

e) a permanent signal of 0,25 V peak from 1 kHz to 1 MHz;

f) a pulse of 20 V of duration 5 µs.

Input impedance at 50 kHz:

g) the input impedance, whether the receiver is powered up or not, at up to 5 V peak, shall consist of a resistance in parallel with a reactance. Energized and non-energized cases have to be considered:

- For an energized station:

  resistance > 20 kΩ

  reactance > 20 kΩ (60 mH) if inductive

  >100 kΩ (30 pF) if capacitive

- For a non-energized station:

  resistance > 10 kΩ

  reactance > 10 kΩ (30 mH) if inductive

  > 50 kΩ (60 pF) if capacitive;

h) internal clamping can occur at more than 5 V peak, provided that the dynamic input impedance above the clamping voltage is > 200 Ω at 50 kHz;

i) minimum input impedance at 50 kHz with an output locked in position transmission of a logical level 1 (no signal on the bus): 200 Ω;

j) the receiver shall tolerate a permanent connection to 230 V mains, at the bus terminals;

k) maximum common mode capacity between bus inputs and other inputs: 15 pF for an energized station and 100 pF for a non-energized station.

All impedances used for measurements as specified in 8 should be of 1 % accuracy.

9 Unidirectional local data transmission interface

9.1 Introduction

The purpose of this clause is to specify the unidirectional communication interface from a Metering device to Consumer Energy Management Systems. This interface is called TIC, "Transmission of Information to the Customer".

Metering equipment based on electronic technology incorporates increasingly varied pricing plans and offer to the grid user information interfaces such as multi-screen displays or programmable output contacts, in addition to the basic metering functions. Most of these devices also integrate options allowing the grid user to obtain real-time information on power consumption and to automatically control loads through a digital information output.

The TIC "Transmission of Information to the Customer" constantly sends out the managed contractual parameters, as well as consumption levels measured by the metering device. This digital information output is refered to as the "information output" in the remainder of the document.

The TIC may be used by the customer to connect to systems such as:

- a remote display,
- a load management device,
- a power manager.

An auxiliary power supply allows connection and use of a wireless interface, such as a radio module, to the information bus.

The TIC uses twisted pair carrier signalling to deliver information by a modulated, wired digital serial connection, which constantly sends out the information managed by the metering device.

The information output is asynchronous, and the information is serially transmitted cyclically over the line. All data transmitted is preceded by a label used to identify it.

The TIC is described as a system defined by three hardware components (transmitter, receiver, bus) and by a protocol with technical, physical and logical characteristics.

9.2 General description

This clause specifies two unidirectional communication profiles for the TIC protocol:

- the Historical TIC,
- the Standard TIC.

9.3 Historical TIC

9.3.1 Overview

The Historical TIC communication profile is the first version of the TIC and has been implemented in ten millions residential and C&I meters already. The main characteristics of the Historical TIC are the following:

9.3.2 Character transmission

The baudrate is fixed and set to 1 200 bauds.

Each character is transmitted in a coherent 10-bit set whose content is as follows:

- a start bit corresponding to a logical "0",
- 7 bits to represent the ASCII character,
- 1 parity bit, even parity,
- a stop bit corresponding to a logical "1".

When a series of bits is sent, the Least Significant Bit (L.S.B.) comes first; the Most Significant Bit (M.S.B.) comes last as per Figure 16.

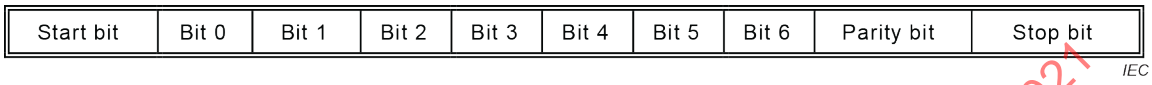


Figure 16 – Character transmission

When a group of information is transmitted, the characters are transmitted in the direction they are read (left to right).

9.3.3 Data transmission protocol

9.3.3.1 General

The TIC continuously transmits frames, one after another. A transmission-free pause is placed between the end of one frame and the start of the next one. Its duration is between 16,7 ms and 33,4 ms.

The frames are of variable length that depends on the type of subscription the Cutomer has from the Distribution Service and contain all the information present in the meter's memories that may help with power management.

A frame is made up of three parts:

- The "Start TeXt" STX (0x02) character indicates the start of the frame,
- The frame body, made up of multiple Information groups,
- The "End TeXt" ETX (0x03) character indicates the end of the frame.

All of the meter's data is delivered by several Information groups that each form a coherent set with a label and an associated value that let them be easily distinguished from one another.

The time between two successive Information groups of a single frame shall not be greater than 33,4 ms.

The content of an Information group is made of seven fields as follows:

- A "Line Feed" LF (0x0A) character indicating the start of the group,
- The Label field, whose length is less than or equal to eight characters,
- A "SPace" SP (0x20) character in Historical mode, as a separator between the "Label" field and the "Data" field,
- The Data field, whose length is defined for each Information group,
- A "SPace" SP (0x20) character in Historical mode, as a separator between the "Data" field and the "checksum" field,
- The "Checksum" field, calculated as given below,

- A "Carriage Return" CR (0x0D) character indicating the end of the Information group.

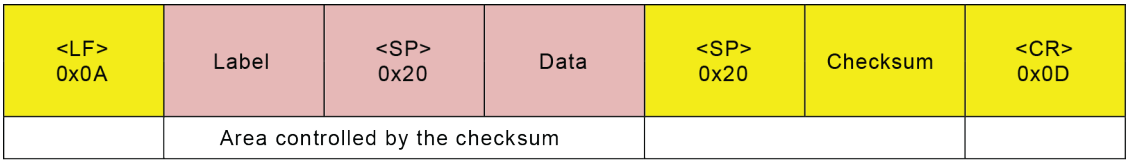


Figure 17 – Historical TIC: information group structure

The Checksum is calculated as follows:

- The *Checksum* is calculated on the fields of the Information group: the Label, the separator, and the Data as shown in the Figure 17.
- This Checksum is then truncated to 6 bits (this is done using a logical AND with 0x3F)
- To get the Checksum, 0x20 is added to the previous result.

The result will therefore always be a printable ASCII character (symbol, numeral, uppercase letter) ranging from 0x20 to 0x5F.

9.3.3.2 Information group construction

9.3.3.2.1 General

The Label and the Data to insert in each Information group are configured in 2 types of list: the Readout lists, associated to the Parameters lists. Both types of list have the same number of elements, settled in the same order.

The list of the parameters contains the identification of the Data as it has to be transmitted on the "information bus" and the Data format. The two lists are of profile generic interface class instances as defined in Clause 6 of IEC 62056-6-2:2017. These profile generic interface class instances may not be available for some applications. In such a case, their content and order shall be defined in a Utility companion specification. As consequence, they cannot be modified on field, unless by firmware upgrade.

9.3.3.2.2 Readout list

The Readout lists are DLMS/COSEM standard readout profile instances. Their capture objects references the Data to be transmitted over the twisted pair signalling carrier line. Each standard readout profile instance is for a given purpose. The Data is transmitted in the order defined by the capture objects attribute of the related profile generic interface class instance.

9.3.3.2.3 Parameters list

9.3.3.2.3.1 General

The parameters consist of the Label of the Data as it has to be transmitted to the Information bus, the Data format, and the optional timestamp.

NOTE Historical applications have no optional timestamp.

9.3.3.2.3.2 Label

The Label is an ASCII string up 8 characters long, containing the identification of the Data to be sent to the "information bus".

9.3.3.2.3.3 Data format

The format parameter carries the format of the Data as it has to be sent on the information bus.

The TIC supports 3 data formats:

String: this format is used for the identification of the device, messages or any other information which needs this format. The Data is a sequence of characters. Example: 031207112233.

Decimal: the decimal format is used for expressing any measured quantity. This quantity can be an energy value, demand, voltage, etc. The following rules apply for decimal values:

- When the related quantity is an energy, a 9 digits decimal format is used meaning from 000 000 000 up to 999 999 999. Energy data are in Wh, varh or vah.
- When the related quantity is a demand, a 5 digits decimal format is used meaning from 00 000 up to 99 999. Demand data are in W, VAR or VA.
- Excepted the subscribed current which is expressed using a 2 digits decimal format, (from 00 up to 99) all the other values related to current as it is transmitted on the information bus use a 3 digits decimal format, meaning from 000 up to 999.
- When the quantity is a duration, it is expressed using 2 digits decimal format from 00 up to 99.
- Current data are in Amps.
- When the related quantity is a voltage, a 3 digits decimal format is used, meaning from 000 to 999. Voltage data are in Volts.

When the current value of the related quantity has fewer digits than the ones specified above, leading zeros are used for filling the related value up to the number of digits specified.

Binary: the binary format is used for expressing any status or output state; the size depends on the kind of data to send out.

The format is carried as an enum having the following values:

(1) String – the length of the string is explicitly defined by the length of the data.
(2) Decimal 2 digits
(3) Decimal 3 digits
(4) Decimal 5 digits
(5) Decimal 9 digits
(6) Binary

9.3.3.3 Process

Every time a frame has to be constructed, the frame is first intialized by the insertion of the Start of TeXT <STX> character at the beginning of the Frame. Then the device, using the Readout List and the related Parameters list, extracts the Label and parameters from the Parameters list on one part, and the Data from the Readout list on the other part.

For each couple of Label and Data, the device

- Prepends the information group data with a Line Feed <LF>,
- Calculates the Checksum related to the Information group,
- Inserts the Checksum after the Information group, and
- Adds a Carriage Return <CR> after the Checksum.

This terminates the process related to an Information group construction. When all the Information groups have been processed, the device closes the frame by adding an End of TeXt <ETX> at the end of the frame, and then perfoms the Physical data transmission on the local data transmission interface.

9.4 Standard TIC

9.4.1 Overview

The standard TIC profile is an enhancement of the Historical TIC profile. The main characteristics of the Standard TIC are the following.

9.4.2 Character transmission

The Standard TIC character transmission is the same than the Historical TIC character transmission (9.3.2). The only difference is that the fixed baudrate is set to 9 600 bauds instead of 1 200 bauds for the Historical TIC.

9.4.3 Data transmission protocol

9.4.3.1 General

The Standard TIC data transmission is similiar to the Historical TIC data transmission. Please refer to 9.3.3. The only difference is the separator which uses the Horizontal TAB ASCII character instead of a SPACE ASCII character, as can be seen in Figure 18 and Figure 19.

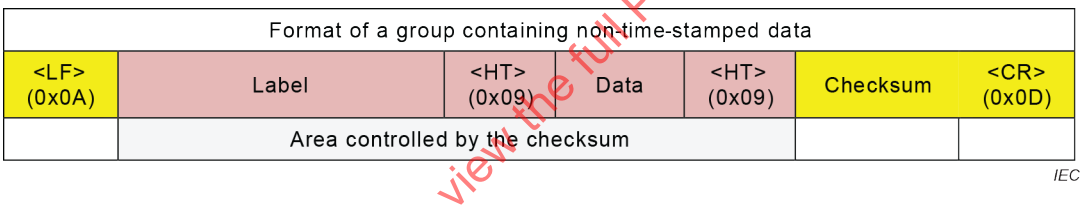


Figure 18 – Standard TIC: Application information group structure

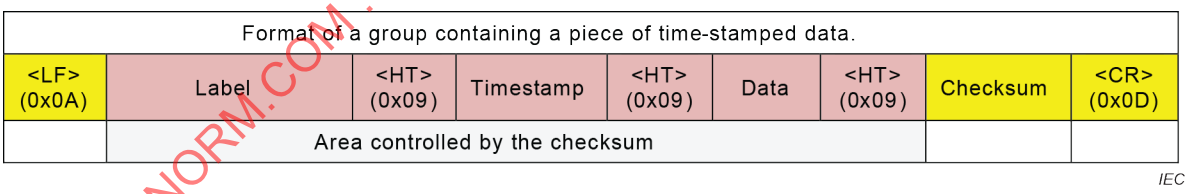


Figure 19 – Standard TIC: Timestamped information group structure

9.4.3.2 TimeStamp

Some data to be sent to the Customer needs to be flagged with their capture time. The format is SYYMMDDhhmmss with the following meaning:

Field	Meaning	Description
S	Season	This field identifies the season, which can be Winter or Summer. • When cleared, the season is WINTER – The S field has to be set to "H" when DST is inactive with (invalid value) and 1 (doubtful value) are both set to 0 in the clock status, – The S field has to be set to "h" if ever the clock status invalid bit or doubtful bits are set to 1. • When set, the season is SUMMER. – The S field has to be set to "E" if ever the clock status bit 0 (invalid value) and 1 (doubtful value) are both set to 0, – The S field has to be set to "e" if ever the clock status invalid bit or doubtful bits are set to 1. • When the season character is not applicable (DST disabled), it has to be replaced by a SPACE. NOTE Doubtful value and invalid bits are those defined in the attribute 4 of the Clock interface class in IEC 62056-6-2:2017, as formatted in 4.1.6.1.
YY	Year	This field holds the 2 last digits in decimal form of the year. The value is from 00 up to 99.
MM	Month	This field holds the value of the month in decimal form. The value is from 01 up to 12.
DD	day	This field holds the day of the month in a decimal form. The value is from 01 up to 31.
hh	hours	This field holds the value of the hours in a decimal form. The value is from 00 up to 23.
mm	minutes	This field holds the value of the minutes in a decimal form. The value is from 00 up to 59.
ss	seconds	This field holds the value of the seconds in a decimal form. The value is from 00 up to 59.

Examples:

- December 25, 2008, at 10:35 pm 18s is coded as: *H081225223518*, with *H* meaning that it is winter.
- July 14, 2009, at 7:45 am 53 s is coded as: *E090714074553*, with *E* meaning that it is summer.

9.5 Unidirectional TIC Hardware

9.5.1 Overview

The physical characteristics of components and signals described in this chapter are consistent with the three unidirectional communication profiles of the TIC protocol.

9.5.2 Output terminal descriptions

The TIC interface has an information output and a power supply output.

The connection is made via a terminal board including 3 terminals. The terminal accepts flexible or rigid cables.

An example of the marking used is given in Table 55.

Table 55 – TIC terminal board pin out

Marking	Function
N	Common
I	Information
A	Power supply

9.5.3 Characteristics of the power supply

The power supply allows customers to connect the output of the TIC to a telecommunication device (a radio module for instance). Wireless communication is of great help when:

- The wired connection is not convenient (in case of walls or long distances between meter and power manager),
- A large number of appliances use TIC data. In this case, the radio device is an efficient way to broadcast data.

The power supply is made available to supply power to a single equipment located close to the meter. Thus, the principle of information bus does not apply to the power supply circuit.

The power supply circuit has the following characteristics:

- Without load: when no load is connected to the output of the power supply, the voltage at the power supply terminals is 13 Vrms max;
- With load: the power supply circuit complies with the characteristics in Table 56.

Table 56 – Power supply characteristics

Power supplied rated	130 mW minimum
Voltage	AC 6 Vrms (±10 %) 50 kHz modulated sinusoidal signal NOTE Maximum peak voltage: 12 V, including signal distorsion.
Protection	• The circuit can support a permanent short circuit • The input/output should withstand to a voltage of 230 V, 50 Hz in case of accidental connection to the customer installation mains

Furthermore, the output impedance of the TIC power supply is purely resistive at 50 kHz.

9.5.4 Characteristics of the information circuit

9.5.4.1 General

The present subclause describes the hardware specifications the information circuit interface shall comply to.

9.5.4.2 Specification of the information bus

Access to the information bus is done via terminals N and I, and the signals may be distributed on a wired bus.

The specifications of this paragraph apply to the information circuit and do not concern the power circuit of the TIC.

In order to ensure correct operation and compliance of the electrical characteristics, the information bus length shall not exceed 500 m (any topology).

The consumer information bus connection terminals shall be galvanically insulated from the transmission electronics within the meters. The internal electronics of the receiving devices shall be galvanically insulated from the bus to enable the simultaneous connection of multiple receivers to a single bus. The purpose of this requirement is to keep common-mode current from travelling between receivers.

The connection cable is an indoor telephone cable with the following properties:

– Single twisted pair and aluminum screen with drain wire;
– Single-strand tinned copper wire 0,5 mm in diameter;
– PVC insulator.

Its electrical characteristics are:

- Continuous loop resistance at 20 °C: 176 to 192 Ω /km.
- Its characteristics at 50 kHz between −15 °C and +45 °C are:
  – Loop resistance: 154 Ω /km to 220 Ω /km.
  – Loop inductance: 500 µH/km to 800 µH/km.
  – Mutual capacity: 80 nF/km to 130 nF/km.
  – Capacity loss factor: 5 % maximum.
  – Unbalanced capacity, conductor-screen: 5 % maximum.
  – Characteristic impedance: 74 Ω to 115 Ω.
  – Linear phase-shift at 50 kHz: 150 degrees/km maximum.

The above characteristics are given for a symmetric source isolated from the cable screen with the impedances Z and Z' greater than 1 000 Ω at 50 kHz (see Figure 20).

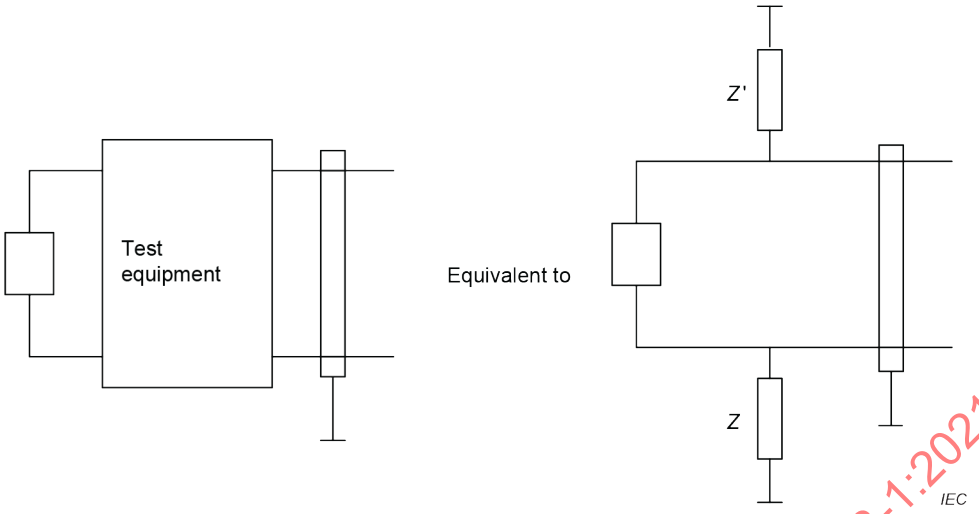


Figure 20 – Equivalent diagram of the test equipment

9.5.4.3 Connecting the information bus

One point of the drain wire shall be connected to earth, if any, or to an equivalent reference potential. No impedance (except the cable itself) of less than 1 000 Ω at 50 kHz shall be connected between the bus cables and that of the screen or the earth.

When using cables slightly outside the above specifications:

– For a cable whose linear resistance or capacity is greater, the bus maximum length shall be reduced. The bus maximum length changes approximately in inverse proportion to the value of the linear resistance or capacity.

– A cable with a lower linear resistance or capacity may lead to excess voltage in the inputs of a receiver placed on an empty and very long bus. This problem may be resolved by placing between the bus leads, near the end opposite the transmitter, a dampening resistor (330 Ω to 1 000 Ω; 0,25 W) whose value depends on the excess voltage ratio. A capacity of 47 nF and appropriate breakdown voltage shall be placed serially with this resistance so as to withstand an accidental connection to the mains.

9.5.5 Characteristic of the signal

9.5.5.1 General

Table 57 shows the main characteristics of the various modes.

Table 57 – Signal characteristics

Characteristics	Historical	Standard
Transmission	Binary by amplidude modulation with a carrier at 50 kHz ± 3 %	
Transmission	Single direction	
Bit duration	Equal duration of bits for "0" and "1"	
Coding logic	Negative: meaning that when the carrier is present the bit is equal to "0" and when the carrier is absent the bit equals to "1".	
Data rate of the transmission	1 200 Bauds ± 1 %	9 600 Bauds ± 1 %

9.5.5.2 General requirements of the signal over the information circuit

The signals present on the bus are defined in Figure 21 and are characterized by the following parameters.

a) Vevh1 is the maximum level of the range for transmitting a "1".

b) Vevl0 is the minimum level of the range for transmitting a "0".

c) Vevh0 is the maximum level of the range for transmitting a "0".

d) Tev1 is the minimum guaranteed time during which the range has a level below Vevh1.

e) Tev0 is the minimum guaranteed time during which the range has a level between Vevl0 and Vevh0.

f) Vevl0 and Vevh0 are not the extremes of the range, but rather the low and high limits for correct operation.

g) During Tev0 the level of the range shall not vary by more than 20 %.

h) During the intervals of time between Tev0 and Tev1, the range's increasing or decreasing is exponential or damped sinusoid with the addition of low-frequency transients.

i) The harmonic distortion rate, during continuous carrier transmission on a load of 100 Ω, is less than 15 %.

j) All the voltages are specified in peak values.

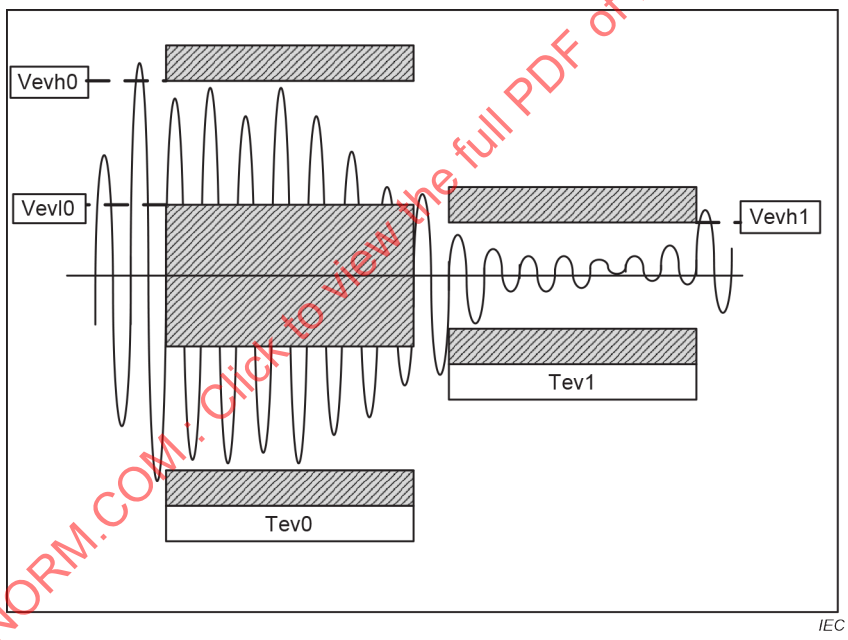


Figure 21 – Signal envelope on the bus

9.5.5.3 Transmitter specific requirements

The TIC transmitters are defined within the particular specifications of metering devices. The physical characteristics adopted for the TIC outputs are the same as those of EURIDIS when not modified by Clause 9. Consequently, the requirements for a TIC transmitter are deduced from the requirements of the transmitters of EURIDIS secondary stations.

The signal transmitted over the bus satisfies the general requirements of 9.5.5.1 and 9.5.5.2 along the entire temperature domain, with:

a) Tev1 = Tev0 = 60 µs at 9 600 bauds
750 µs at 1 200 bauds.

When the two connection terminals to the information bus are in open circuit, the following condition shall be met:

b) Vevh0 = 25 V.

When the two connection terminals to the information bus are connected to a resistor ranging from 100 Ω to 2 kΩ, the following condition shall be met:

c) Vevl0 = 1,2 V;

d) Vevh0 = 5 V;

e) Vevh1= 0,2 V.

When the two connection terminals to the information bus are connected to a 31,8 nF capacitor in series with a 1 Ω resistor, the signal being measured at the terminals of the 1 Ω resistor, and multiplied by 100, the following condition shall be met:

f) Vevl0 = 1,5 V.

g) Vevh0 = 5 V.

h) Vevh1 = 0,2 V.

NOTE Measuring these voltages, across a capacity, may show an abnormal amplification of the low-frequency transients.

Additionally, when the two connection terminals to the information bus are connected to a 100 Ω resistor or to a 31,8 nF capacitor, the following condition shall be met:

i) Parasite signals due to switching from transmission mode (logical "1") to blocked mode (logical "0") and vice versa shall not exceed 0,75 V peak in any case.

j) The noise level measured at the terminals of the information bus, in any case, and in the frequency range [1 kHz; 1 MHz], shall not exceed 50 mV after that the transients have elapsed.

In addition:

k) The transmission circuits shall withstand a permanent short-circuit and the accidental connection of a 230 V, 50 Hz network to the outputs terminals.

l) The short-circuit current shall not be destructive to the components of the transmission circuits (no requirement on the value of the short-circuit current. It should be consistent with the specifications of the equipment, including specific consumptions of the TIC).

m) Common-mode capacity between terminals of the information bus and the other terminals of the metering device is below 15 pF.

9.5.5.4 Receiver specific requirements

A device receiving signals from the information bus is declared compatible with the TIC transmitters if it interprets correctly the transmitted messages under the conditions described above (9.5.5.3).

A conformity test should make it possible to guarantee that devices are compliant with the characteristics specified herein.

It is also recommended the presence on this hardware of an indicator light showing that the device is receiving data transmitted by the meter.

Furthermore, the integration of the consumer's information networks' topological restrictions makes it possible to describe the input characteristics and the sensitivity levels that the receivers shall take into account in order to ensure this compatibility.

Thus, this subclause's requirements allow the connection (without any position restrictions) of 1 up to 5 receivers onto a single client information bus.

To comply with this background, the receiver shall work correctly with an input signal that verifies the following characteristics:

a) Tev1 = Tev0 = 50 µs at 9 600 bauds,
700 µs at 1 200 bauds.

Following values are obtained with a signal generator whose internal impedance is negligible compared to the receiver's input impedance.

b) Vevh1 = 0,4 V.

c) Vevl0 = 0,8 V.

d) Vevh0 = 5 V.

When the TIC is used with a bus, specific attention shall be paid to the bus and the receivers design. The receivers input signals levels may exceed the levels specified for direct connexion (LC circuits).

In addition, the receiver shall be insensitive to:

e) A permanent sinusoid signal whose frequency is within the range: [1 kHz; 1 MHz] and whose peak value is equal to 0,1 V.

f) A harmonic distortion of 50 %.

g) A 20 V pulse lasting 5 µs.

The receiver's input impedance at 50 kHz includes a resistive component in parallel with a reactive component.

For signals running up to 5 V peak, the following values are to be followed whether or not the receiver is powered:

h) A resistive parallel component between 500 Ω and 2 000 Ω,
reactive parallel component: > 2 000 Ω,if it is inductive,
> 10 k Ω, if it is capacitive.

i) In the case of a malfunction in the reception electronics, the receiver input impedance shall remain above 200 Ω.

Additionally, the physical construction of the receiver makes it possible to verify the following points:

j) Common-mode capacity between the connection terminals to the customer information system bus and the other terminals of the receiver device is below 15 pF.

k) When a permanent voltage of 230 V 50 Hz is applied on his input terminals, the receiver device shall not damage to the circuits of the meter (information circuit and power supply circuit).

Annex A
(normative)

Specification language

A.1 Vocabulary and operating rules

To describe the role of each layer of the local bus data exchange profiles unambiguously, the specification uses a table formalism modelling the real behaviour by a controller with a finite number of states.

To each controller corresponds a unique logic table; this logic table may be broken down into several physical tables if it is particularly large.

To each controller occurrence corresponds an instance (distinct active copy) of the logic table of the reference controller.

Each physical table consists of lines known as state lines. Each state line describes the triggering condition (column 2) for the machine to pass from an initial state (column 1) to a final state (column 4) by executing a set of actions (column 3).

The first initial state is the start-up state of the controller. This state is unique; it is particularized by means of italic characters.

A stop state of the controller is a final state for which no state line is defined with this state as initial state. A controller is infinite when it does not have a stop state. A finite controller may have one or more stop states. These states are also represented by using italic characters. This convention means that the order in which the states are presented in a physical table is not important.

The same rule applies when several state lines refer to the same initial state, because the triggering conditions are always mutually exclusive. The order of the lines in a physical table is therefore governed by presentation considerations only. Nevertheless, it is logical to begin by describing the transitions of the start-up state.

A set of actions in a state line shall be considered as a critical section (i.e. an uninterruptible sequence). The actions described there shall be executed in the order in which they are written. An action is defined by an invocation of a named procedure instantiated with a zero list, one or more parameters between parentheses. All referenced named procedures shall be the subject of separate descriptions. However, there are two predefined actions: assignment = and empty action $none() (no action).

The triggering condition associated with a state line may be composed of several sub-conditions. The assessment of a composite triggering condition always involves the assessment of all the sub-conditions that it contains. Therefore, the order in which the sub-conditions are written is unimportant.

The operators supported for expressing composite conditions are the logic operators & (logic and), | (logic or), not() (logic no) and the comparison operators (<, >, <=, >=, = and <>).

There are two types of triggering condition.

A simple condition is assessed instantaneously, by definition. It may be composite but, in such cases, all the sub-conditions shall be of the simple type. A boolean named function is an example of a simple condition. All referenced boolean named functions shall be the subject of separate descriptions.

An event condition expresses the wait for an event. It may be composed of several events or simple sub-conditions.

When the assessment of a triggering condition gives a true result, the condition is satisfied. The satisfaction of a triggering condition always leads to a state transition.

An event can be defined as an element contributing to the satisfaction of an event-type triggering condition.

When an event is included in an event-type triggering condition which is satisfied, it is automatically consumed. An event can be consumed only once.

Any event that occurs when the controller occurrence that is likely to consume it is in a state where this consumption is impossible is stored chronologically in an area known as the inter-controller queue.

Each controller thus has a single queue that it shares between its own controller occurrences. The size of this queue is assumed to be quasi-infinite; its organization and its management are not described here. However, it should be noted that a partial purge of the queue (i.e. related only to the events concerning the current controller occurrence) is automatically carried out for any state transition starting from the start-up state.

There shall also be a self-purge mechanism for automatic deletion of incoming events that are manifestly not consumable. Moreover, there is a predefined named procedure $purge(), which corresponds to the action of total purge of the current inter-controller queue. All the occurrences of the corresponding controller then return to the start-up state.

Events are produced by some of the described actions in a set of actions associated with a state line. An internal event can be consumed only by the controller that has produced it. An external event is always consumed by a controller other than the one that has produced it.

It should be noted that the absence of an event (expressed by an event sub-condition encapsulated in the logic operator not()) is always a simple sub-condition.

When, for an initial state, there is a state line where the triggering condition is of a certain type (simple or event), then all the state lines having the same initial state shall have triggering conditions of the same type.

When this type is simple, the initial state is called sub-state. A sub-state is particularized by means of the italic attribute. It is transient and can always be removed; its presence in a physical table is justified only by improved clarity of presentation. In the special case of a start-up sub-state, a special condition has been predefined: $true(), which is always true.

The variables referred to in the triggering conditions and the actions described in a physical table remain local with respect to each controller occurrence. There is also a predefined variable (the unlinked variable _) intended to replace any unused parameter in any function or named procedure.

A.2 Entity and Entity Invocation

It is interesting to draw a parallel between the elements of the specification language described herein and certain concepts developed by the OSI (Open Systems Interconnection).

For each layer, for example, the notion of Entity corresponds to a controller, while the term Entity Invocation is similar to controller occurrence.

Annex B
(normative)

Timing types and characteristics

B.1 Timing type definition

Timings are classified into several types:

Logical timing: TL type

defined from Stop-bit to Stop-bit (Figure B.1).

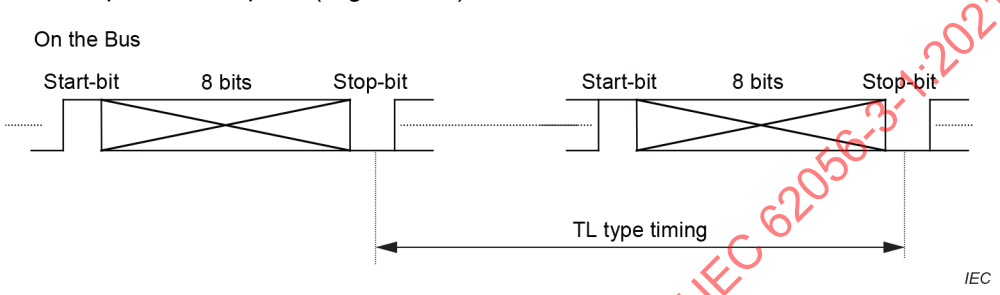


Figure B.1 – Logical timing type

Physical timing: TPFD or TPDF

Defined from End of carrier to Start of carrier for TPFD timing and from Start of carrier to End of carrier for TPDF timing (Figure B.2).

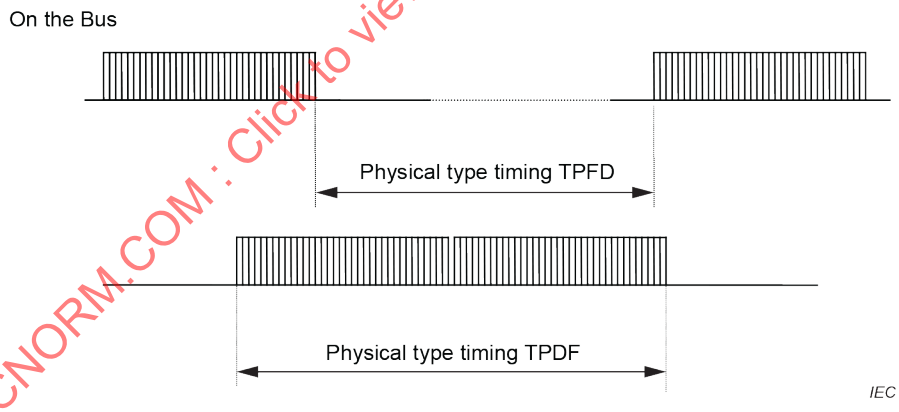


Figure B.2 – Physical timing type

Semi-Logical timing: TSL1 type

Measured from End of carrier or End of event to Stop-bit.

Semi-Logical timing: TSL2 type

Measured from End of event to Start-bit.

Chrono Timing: Tc type

Triggered by event and stopped automatically after programmed delay.

Specific Timing: Ta type

Depending of bus energy supply: TICB is Ta type.

B.2 Timing measurements and characteristics

Timing precision is ±1 %. The minimum value cannot be under ±10 ms.

Each timing limit value in the arrays takes this characteristic into account. Results shall be treated in the following way (see Figure B.3 and Figure B.4):

a) High Limit – Tolerance > M > Low Limit + Tolerance, result is 100 % OK;

b) M < Low Limit – Tolerance, result is 100 % NOK;

c) M > High Limit + Tolerance, result is 100 % NOK;

d) (Low Limit – Tolerance) < M < (Low Limit + Tolerance), result is not determined, OK or NOK;

e) (High Limit – Tolerance) < M < (High Limit + Tolerance), result is not determined, OK or NOK.

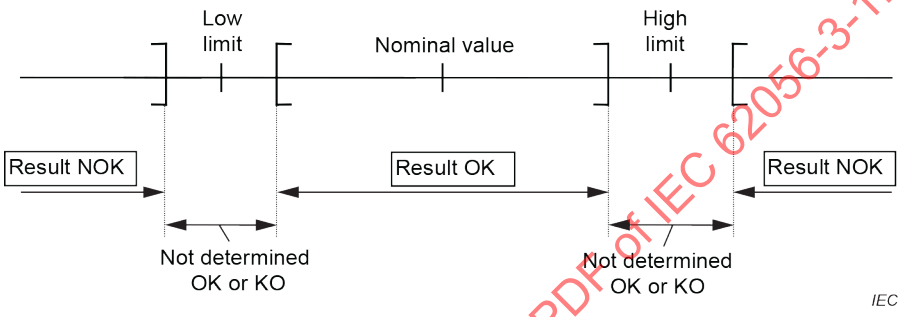


Figure B.3 – Results processing for timing defined with low and high limits

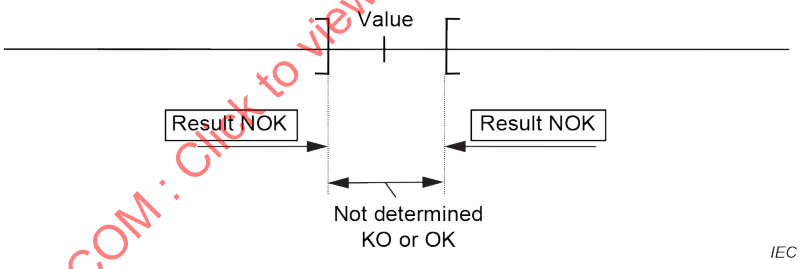


Figure B.4 – Results processing for timing defined by a nominal value

Annex C
(normative)

List of fatal errors

Any occurrence of one of the listed fatal errors is sent up locally to the *Application* layer.

Table C.1 – FatalError error numbers

Number	1	2	3	4	5	6	7	8
Error	**EP-3F**	**EP-4F**	**EP-5F**	**EL-1F**	**EL-2F**	**EA-1F**	**EA-2F**	**EA-3F**

Whatever layer is involved, the occurrence of a fatal error results in:

- if appropriate, stopping of the next lower layer by means of the service primitive abort.req;
- if appropriate, informing of the next higher level by means of the primitive abort.ind with the number of the fatal error as parameter;
- complete reinitialization of the corresponding controller occurrence.

Annex D
(normative)

Coding the command code field of frames

D.1 Command codes for local bus data exchange (Table D.1)

Table D.1 – Command codes for local bus data exchange

Abbreviation	Hexa value	Binary value	Role
The following codes are used without DLMS			
ENQ	01	0000 0001	Request for remote reading
DAT	02	0000 0010	Response of remote reading
REC	03	0000 0011	Request for remote programming
ECH	04	0000 0100	Data echo during remote programming
AUT	05	0000 0101	Authentication command
EOS	06	0000 0110	End of session
ASO	07	0000 0111	Forgotten stations call
RSO	08	0000 1000	Forgotten stations response
IB	09	0000 1001	Bus initialization
DRJ	0A	0000 1010	Rejection of remote programming data
ARJ	0B	0000 1011	Rejection of remote programming authentication
TRF	0C	0000 1100	Point to point remote transfer
TRB	0D	0000 1101	Broadcast remote transfer (not acknowledged)
TRA	0E	0000 1110	Point to point remote transfer acknowledgement
PRE	10	0001 0000	Non-energized station selection
SEL	11	0001 0001	Non-energized station selection acknowledgement
The following codes are used only with DLMS/COSEM			
XBR	12	0001 0010	Change baudrate request
XBA	13	0001 0011	Change baudrate response

The commands listed in Table D.1 are also used by the Support Manager Layer in DLMS/COSEM environment and in DLMS for the management of the bus initialisation, the discover and the transmission speed negotiation processes.

D.2 Codes of commands for data exchange on the local bus with DLMS or DLMS/COSEM

In order not to confuse DATA+ frame with frames from the profile without DLMS, the DATA+, Priority, Send and Confirm fields make up a special command code COM whose values have been chosen different from the already reserved COM values (Table D.2).

Table D.2 – Command codes with DLMS and DLMS/COSEM

Abbrev.	Hexa value	Binary value	Role
ND1	E0	1110 0000	Normal data (Priority="0"B) with sequence number="0000"B
ND2	E3	1110 0011	Normal data (Priority="0"B) with sequence number="0011"B
ND3	EC	1110 1100	Normal data (Priority="0"B) with sequence number="1100"B
ND4	EF	1110 1111	Normal data (Priority="0"B) with sequence number="1111"B
UD1	F0	1111 0000	Urgent data (Priority="1"B) with sequence number="0000"B
UD2	F3	1111 0011	Urgent data (Priority="1"B) with sequence number="0011"B
UD3	FC	1111 1100	Urgent data (Priority="1"B) with sequence number="1100"B
UD4	FF	1111 1111	Urgent data (Priority="1"B) with sequence number="1111"B

Annex E
(normative)

Principle of the CRC

E.1 General

The checking of the correct transmission of the bits is made globally on an information block expressed in bytes (refer to the Data Link layer). The check key is a set of bits known as the check field. Its calculation is based on the theory of cyclic codes which uses the division of polynomials and the algebraic properties of the remainders of the division of polynomials.

E.2 Operations on the polynomials

Let A = (a_1, a_2,..., a_n) be the bit string for which the check key shall be calculated. This string can be viewed as a polynomial of degree n-1:

$$A(X) = a_1X^{n-1} + ... + a_{n-1}X + a_n$$

Take a divisor polynomial D(X) of degree m. The polynomial division of $A(X)*X^m$ by D(X) gives the following formula:

$A(X)*X^m = D(X)*Q(X) + R(X)$
where R(X) is a polynomial of degree less than or equal to m-1
representing the bit string R = (r_1, r_2,..., r_m)

Given the properties of boolean arithmetic, this formula can also be written:

$A(X)*X^m + R(X) = A(X)*X^m - R(X) = D(X)*Q(X)$
which represents the bit string (a_1, a_2,..., a_n, r_1, r_2,..., r_m)

E.3 Check procedure

The CRC (Cyclical Redundancy Check) check field is represented by the bit string R = (r_1, r_2,..., r_m). Its routine practical calculation is based on shift registers and accumulator registers enabling the key to be calculated as the data bits arrive. The corresponding algorithm will not be described here.

As the theory indicates, the Transmitter shall assess the bit string R = (r_1, r_2,..., r_m), concatenate this string with the bit sequence to be protected A = (a_1, a_2,..., a_n) and transmit the resulting bit string (a_1, a_2,..., a_n, r_1, r_2,..., r_m) to the Receiver.

The Receiver considers that there is no transmission error when the bit string received corresponds to a polynomial of degree m+n-1 exactly divisible by D(X).

E.4 Operating parameters

For the concrete implementation of the algorithm, the chosen parameters are:

m	16
D(X)	$X^{16} + X^{15} + X^2 + 1$

Annex F
(normative)

Random integer generation for response from forgotten stations

F.1 General

The forgotten station call exchanges require the generation and the processing of random integers in the range [0, MaxRSO[to manage several time slots.

F.2 Criterion for a random integer

Rather than specifying a dedicated solution or algorithm, the following criterion has been chosen for focusing on a random integer.

"Whatever an integer I in the range [0, n[, this number I is known as random when its apparition probability is always included in the range [100/n – D, 100/n + D], provided that a significant number of N draws has been respected in a relatively short time T."

F.3 Operating parameters

In the case of RSO time slots for the processing of a "Forgotten Stations Call", the value of the maximum number, MaxRSO, is set to 3. Under this condition, the choice of N, T and D parameters have been chosen as follows:

N	T	D
≤ 100	≤ 10 min	≤ 7

Annex G
(normative)

Random number generation for authentication (profile without DLMS)

According to the DES (Data Encryption Standard) standard algorithm, the authentication exchanges require the generation and the processing of 64 bit random numbers.

Two criteria allowing implementation control are specified rather than a specific solution:

a) First criterion – Hamming Distance

Random number NAi(k), generated by a primary station (i=1) or a secondary station (i=2), shall have a Hamming Distance Dh greater than 4 with each anterior random number in a window k of 400 values observed on the bus.

It is given by the formula:

For observation k, Dh [NAi(n+k), NAi(n+k-l)] > 4, with 0 < l < k

Successive observation number k is 400. Observation starts with k = 0 and first random number has the value NAi(n).

Observations occur with a minimum 1 s delay.

b) Second criterion – Probability of Bit Distribution

From the complete bit range of row i taken from the 400 random numbers previously mentioned, the probability of appearance of an 0 or 1 value have to be between 0,35 and 0,65.

It is given by the formula:

$0{,}35 < [Pr(BitVal\ 2^i) = 0] < 0{,}65$ for $0 \leq i \leq 63$

$0{,}35 < [Pr(BitVal\ 2^i) = 1] < 0{,}65$ for $0 \leq i \leq 63$

Annex H
(normative)

Systems management implementation

To ensure a maximum compatibility (for stations including DLMS and DLMS/COSEM or not), it is proposed to implement the systems management by using the forgotten station call mechanism (Table H.1).

Table H.1 – Discovery service

Discover request	Discover response
ASO frame with 2 bytes in the TABi field (the first corresponds to the reserved TAB 0 and the second is the response probability value)	Standard RSO frame including the System Title (ADS)

Below are the service specifications of the discovery service (Table H.2).

Table H.2 – Service specification

Procedure or function (Primary Station)	Definition
discover.request(energized, adp, response-probability)	energized: TRUE for discovering new energized stations and FALSE for discovering new non-energized stations ADP: Physical address of the Primary Station response-probability: required probability of answer
discover.confirm (collision, discover-list)	collision: TRUE if collision has occurred, FALSE if not discover-list: list of the ADS of the new stations discovered

On the Secondary Station, the Discover service requires the generation of random integers in the range [0, 100] to issue a Discover response. The random function shall have a random behaviour of ±10 %. Thus, for a significant number *N* of systems (*N* greater than 10), the reporting systems number shall be (Response Probability × *N*) / 100 at ±10 %.

Annex I
(informative)

Information about exchanges

I.1 Non-energized station session (Figure I.1)

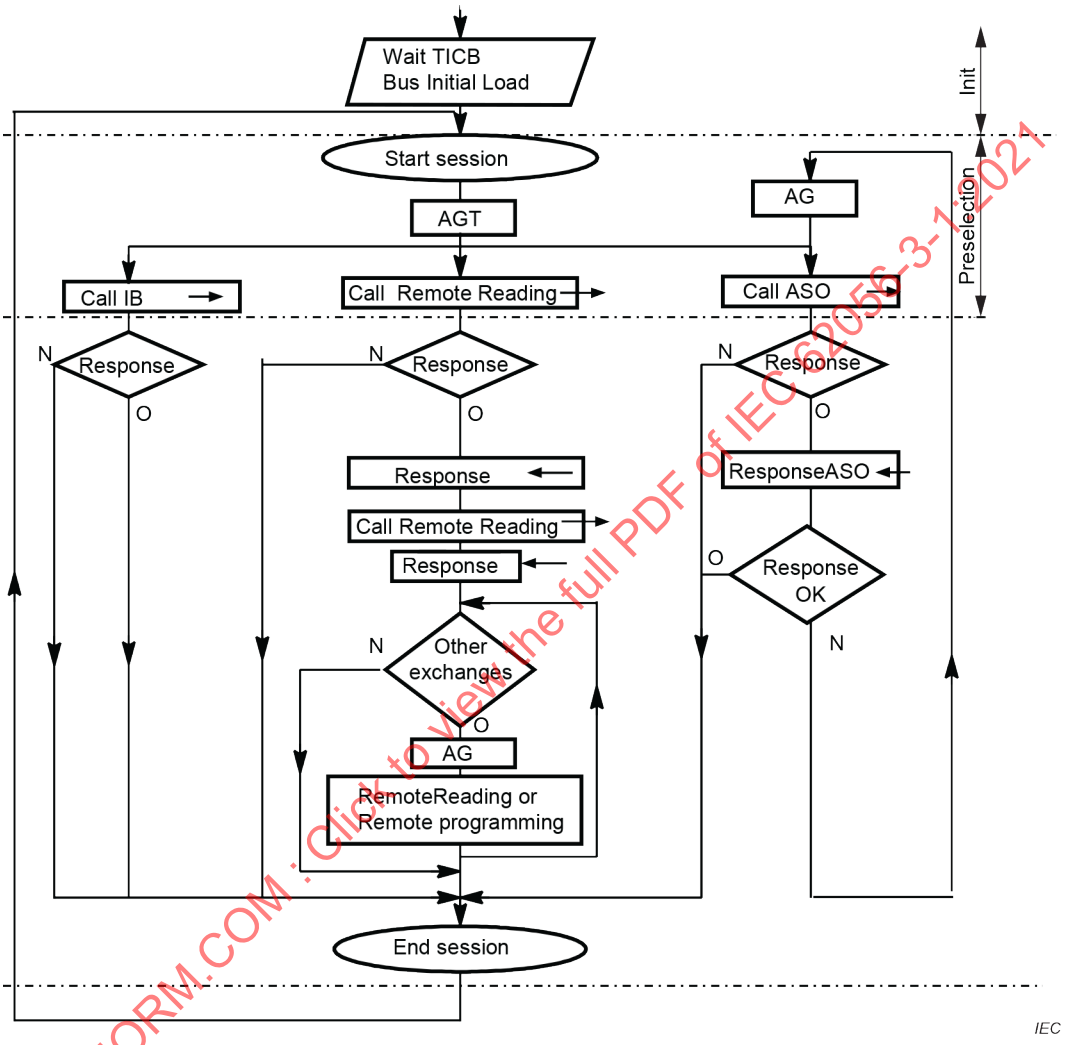


Figure I.1 – Non-energized station session

I.2 Remote reading and programming exchanges (Figure I.2)

NOTE This clause is relevant only for the profile without DLMS.

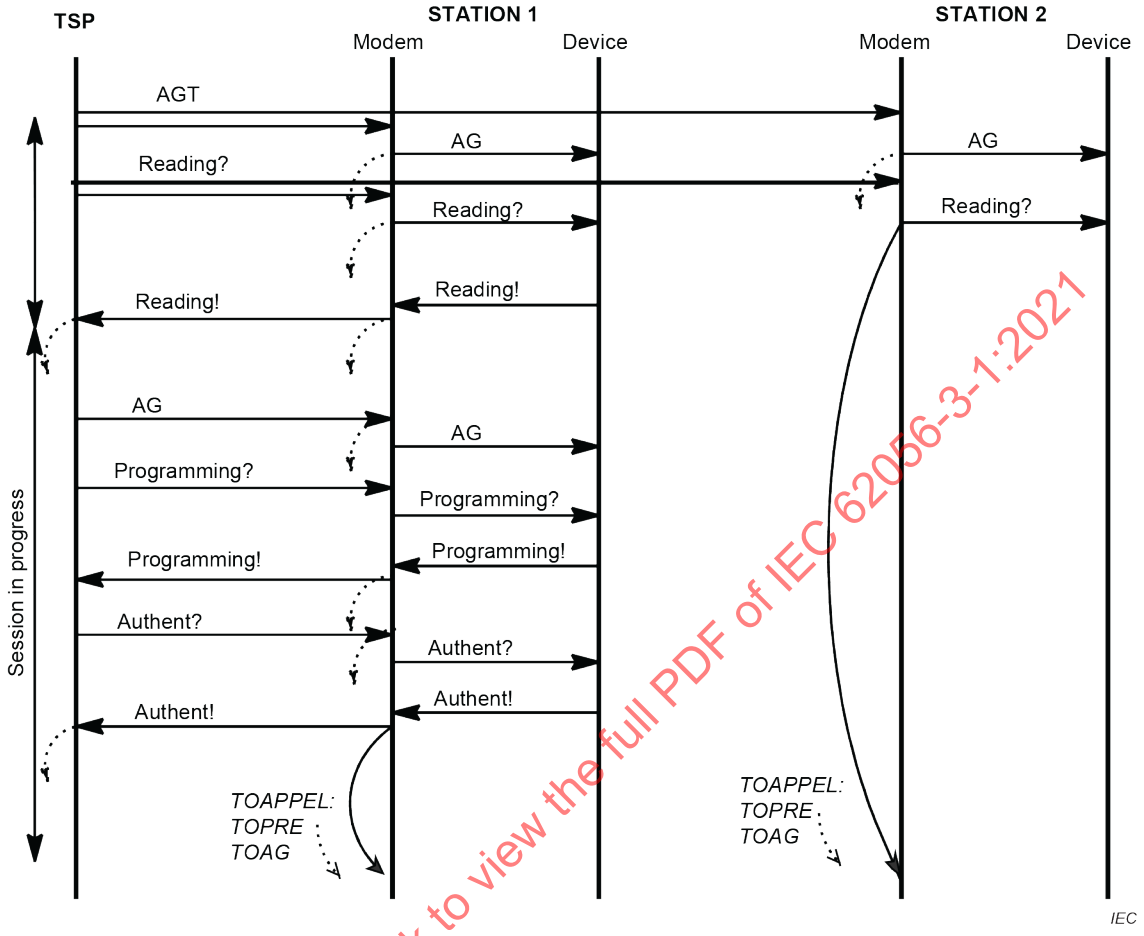


Figure I.2 – Remote reading and programming exchanges

The Primary Station sends an AGT "wakeup Call" signal towards the non-energized Secondary Station. After filtering by its modem, the Secondary Station receives an AGN signal, and it initializes the timer TOAPPEL (maximum waiting time for selection frame).

The Primary Station sends a remote reading frame to the Secondary Station 1. The Secondary Station 2 does not answer, and goes back to a low consumption state when there is a time out of TOPRE. The station 1 answers: it is selected. The example is a sequence of remote reading exchange and a remote programming exchange. The session is checked by the wakeup TOAG.

I.3 Bus initialization frame (Figure I.3)

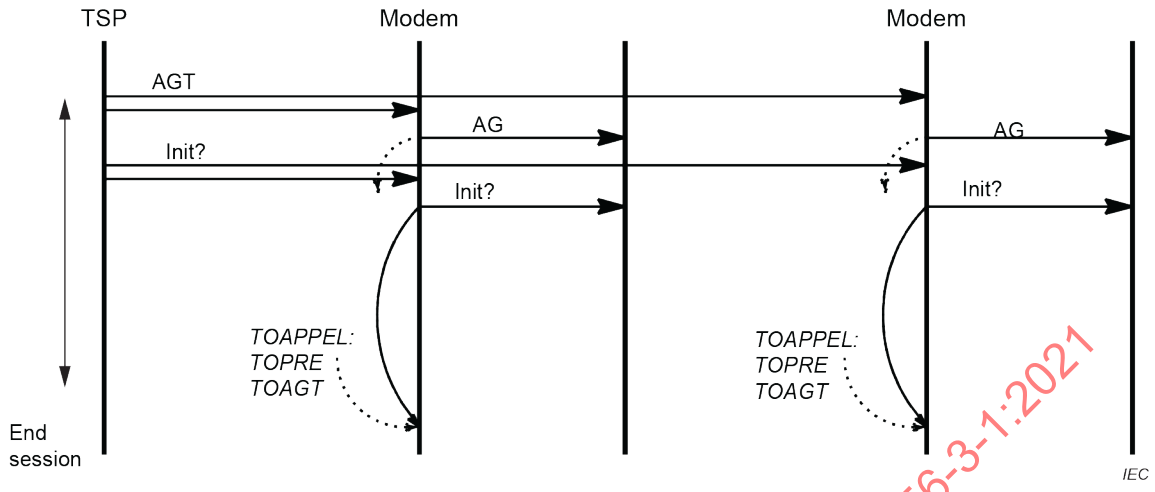


Figure I.3 – Bus initialization

The Primary Station sends an AGT "Wakeup Call" signal and a bus initialization frame. All the non-energized Secondary Stations wake up. The IB frame does not involve any frame answer, thus all the stations go back to a low consumption state.

I.4 Forgotten station call exchange (Figure I.4)

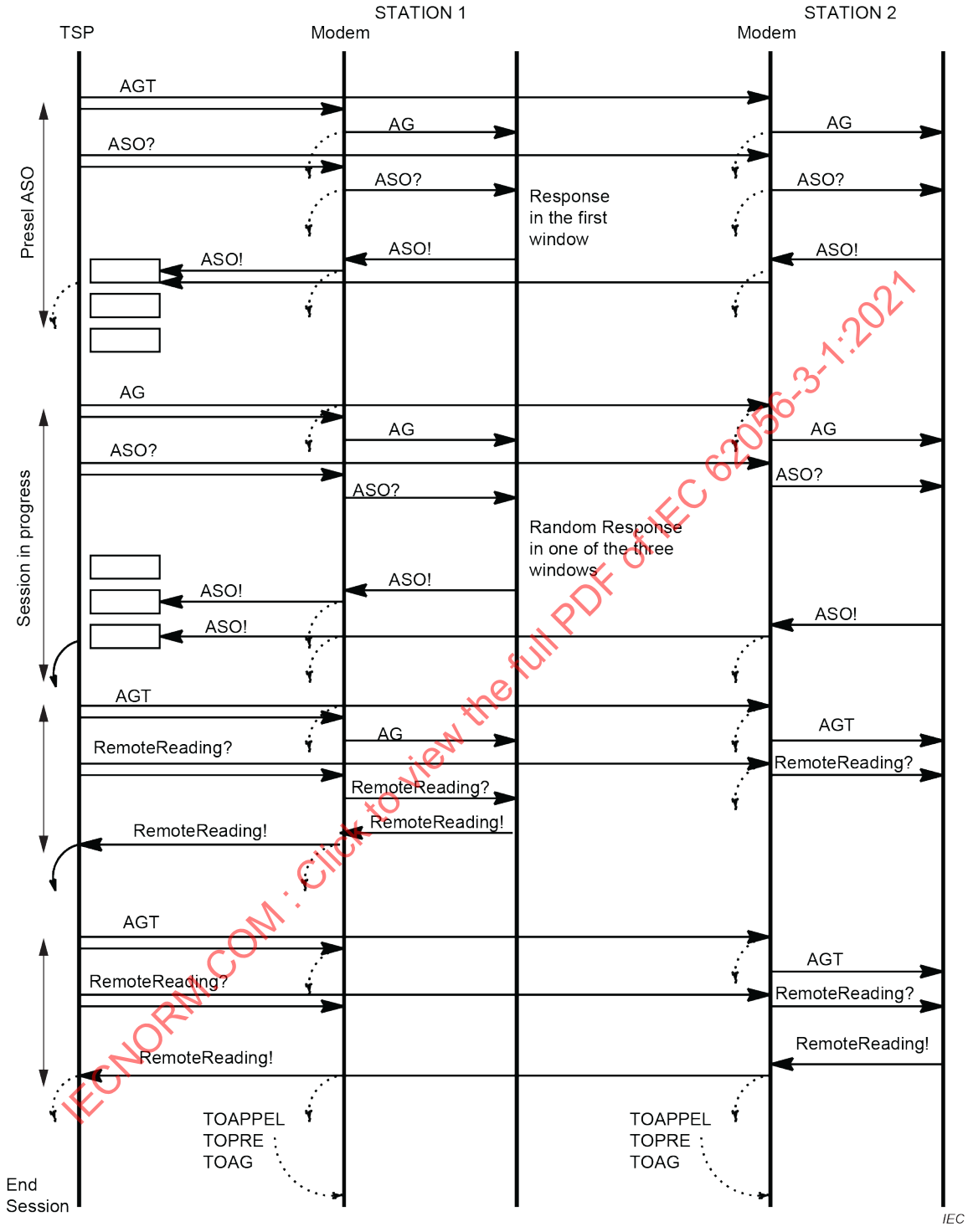


Figure I.4 – Forgotten station call exchange

In this case, two Secondary Stations are "forgotten stations". At the first forgotten station call request (preselection request), both stations answer in the first time slot. At the next forgotten station call exchange, station 1 answers in the second time slot, while station 2 chooses the third time slot.

Bibliography

IEC 62056-6-1:2017, *Electricity metering data exchange – The DLMS/COSEM suite – Part 6-1: Object Identification System (OBIS)*

SOMMAIRE

COMMISSION ÉLECTRONIQUE INTERNATIONALE

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ÉCHANGE DES DONNÉES DE COMPTAGE DE L'ÉLECTRICITÉ – LA SUITE DLMS/COSEM –

Partie 3-1: Utilisation des réseaux locaux sur paire torsadée avec signal de porteuse

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La présente Norme internationale IEC 62056-3-1 a été établie par le comité d'études 13 de l'IEC: Comptage et pilotage de l'énergie électrique.

Cette deuxième édition annule et remplace la première édition de l'IEC 62056-3-1, parue en 2013. Cette édition constitue une révision technique.

Les principales modifications techniques par rapport à l'édition précédente sont les suivantes:

- Ajout d'un profil qui permet l'utilisation de la couche Application et la modélisation objet DLMS/COSEM de l'IEC 62056;

- Révision de la couche liaison de données qui est maintenant scindée en deux parties:
  - la première est intégralement une couche de liaison de données;
  - la dernière, nommée “Gestion du Support”, gère le média de communication;
- Capacité de négocier la vitesse de communication, portant la vitesse maximale jusqu’à 9 600 bauds.

Le texte de cette Norme internationale est issu des documents suivants:

CDV	Rapport de vote
13/1794/CDV	13/1823/RVC

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

Une liste de toutes les parties de la série IEC 62056, publiées sous le titre général *Échange des données de comptage de l'électricité – La suite DLMS/COSEM,* peut être consultée sur le site web de l'IEC.

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ÉCHANGE DES DONNÉES DE COMPTAGE DE L'ÉLECTRICITÉ – LA SUITE DLMS/COSEM –

Partie 3-1: Utilisation des réseaux locaux sur paire torsadée avec signal de porteuse

1 Domaine d'application

Cette partie de l'IEC 62056 décrit deux ensembles de profils: le premier ensemble permet une communication bidirectionnelle entre un client et un serveur. Cet ensemble est composé de trois profils permettant l'échange de données par bus en local avec des stations alimentées ou non en énergie. Pour les stations téléalimentées, le bus fournit l'énergie pour l'échange des données. Trois différents profils sont pris en charge:

- Profil de base: ce profil en trois couches fournit des services de télérelevé;

  NOTE 1 Ce profil a été publié dans l'IEC 61142:1993 et était alors connu sous le nom de Norme Euridis.

- Profil avec DLMS: ce profil permet l'utilisation des services DLMS tels qu'ils sont spécifiés dans l'IEC 61334-4-41;

  NOTE 2 Ce deuxième profil a été publié dans l'IEC 62056-31:1999.

- Profil avec DLMS/COSEM: ce profil permet l'utilisation de la couche Application de DLMS/COSEM et le modèle objet COSEM tels qu'ils sont spécifiés respectivement dans l'IEC 62056-5-3 et dans l'IEC 62056-6-2.

Les trois profils utilisent la même couche physique et ils sont entièrement compatibles, c'est-à-dire que des dispositifs mettant en œuvre l'un de ces profils peuvent fonctionner sur le même bus. Le moyen de transmission est la paire torsadée par signal de porteuse et connue sous le nom de Bus Euridis.

Le deuxième ensemble de profils permet une communication unidirectionnelle entre un dispositif de comptage de l'énergie (*energy metering device*) donné et un système de gestion de l'énergie client (*customer energy management system*). Ce deuxième ensemble est composé de trois profils.

Le paragraphe 4.2.1 à l'Article 8 inclus spécifient la communication bidirectionnelle utilisant le signal avec paire torsadée et l'Article 9 au 9.5 spécifient la communication unidirectionnelle utilisant le signal avec paire torsadée.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris d'éventuels amendements).

IEC 61334-4-41:1996, *Automatisation de la distribution à l'aide de systèmes de communication à courants porteurs – Partie 4: Protocoles de communication de données – Section 41: Protocoles d'application – Spécification des messages de ligne de distribution*

IEC 62056-51:1998, *Comptage de l'électricité – Échange de données pour la lecture des compteurs, le contrôle des tarifs et de la charge – Partie 51: Protocoles de couche application*

IEC 62056-5-3:2017, *Échange des données de comptage de l'électricité – La suite DLMS/COSEM – Partie 5-3: Couche application DLMS/COSEM*

IEC 62056-6-2:2017, *Echange des données de comptage de l'électricité – La suite DLMS/COSEM – Partie 6-2: Classes d'interfaces COSEM*

ISO/IEC 8482:1993, *Technologies de l'information – Télécommunications et échange d'informations entre systèmes – Interconnexions multipoints par paire torsadée* (disponible en anglais seulement)

EIA 485, *Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems*

3 Termes, définitions et termes abrégés

3.1 Termes et définitions

Aucun terme n'est défini dans le présent document.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.2 Termes abrégés

ADP	Adresse de la station primaire
ADG	Adresse secondaire générale. Adresse de diffusion
ADS	Adresse de la station secondaire
AGN	Appel général normal
AGT	Appel général pour station téléalimentée
APDU	Application Protocol Data Unit (Unité de Données du Protocole d'Application)
APG	Adresse primaire générale
ARJ	Valeur du champ COM: Rejet d'authentification en téléprogrammation.
ASDU	Application Service Data Unit (Unité de données de service Application)
ASO	Valeur du champ COM: Appel des stations oubliées
AUT	Valeur du champ COM: Commande d'authentification
COM	Champ contrôle de la couche liaison de données
COSEM	Companion Specification for Energy Metering (Spécification d'accompagnement pour le comptage de l'énergie)
DAT	Valeur du champ COM: Réponse de télérelève
DES	Data Encryption Standard (Norme de cryptage de données)
DLMS	Distribution Line Message Spécification (Spécification de Message de la Ligne de Distribution) (IEC 61334-4-41) Device Language Message Specification (Spécification de Message de langage du dispositif) (IEC 62056-5-3)
DSDU	Data link Service Data Unit (Unité de données de Service Liaison de données)
DRJ	Valeur du champ COM: Data Rejected (données rejetées) Valeur du champ COM notifiant le rejet des données de téléprogrammation.
Dsap	Étiquette des unités de données Transport. Codé sur 3 bits. Sa valeur est 6.

DTSAP	Destination of Transport Service Access Point (destination du point d'accès au service Transport)
ECH	Valeur du champ COM: Écho des données de téléprogrammation
ENQ	Demande de télérelève
EOS	Valeur du champ COM: Fin de téléprogrammation.
IB	Initialisation de bus
LDTI	Local Data Transmission Interface (Interface de Transmission des Données locales)
MaxRetry	Nombre maximal de réémissions. Limité à 2.
MaxRSO	Nombre maximal de fenêtres d'écoute RSO. Fixé à 3.
PDU	Protocol Data Unit (Unité de données du Protocole)
PRE	Valeur du champ COM: Présélection des stations téléalimentées
REC	Valeur du champ COM: Demande de téléprogrammation
RSO	Valeur du champ COM: Réponse à l'appel des stations oubliées
SEL	Valeur du champ COM: Acquittement de la présélection des stations téléalimentées
STSAP	Source Transport Service Access Point
TAB	Dans le cas des profils EURIDIS sans DLMS et sans DLMS/COSEM: code de données. Dans le cas des profils utilisant DLMS ou DLMS/COSEM: valeur à laquelle l'appareil est sensibilisé au Discover.
TABi	Liste de champ TAB
TASB	Duration of an Alarm Signal on the Bus (Durée d'un signal d'alarme sur le bus)
TIC	Transmission of Information to the Customer (Transmission d'informations au Client)
TOAG	Temps d'attente maximal pour une station téléalimentée lorsqu'elle est sélectionnée pour reconnaître un appel général AGN.
TOALR	Attente avant envoi d'un AGN après réception d'un AGN ou d'un AGT
TOL	Temps d'attente maximale d'une requête issue de la couche supérieure
TOPRE	Temps d'attente maximale d'une réponse à une présélection
TOU	Temps d'Utilisation
TPDU	Transport Protocol Data Unit (Unité de données de Protocole Transport)
TSDU	Transport Protocol Service Unit (Unité de données de Service Transport)
TRA	Valeur du champ COM: Acquittement de transfert en point à point
TRB	Valeur du champ COM: Télétransfert en diffusion non acquitté
TRF	Valeur du champ COM: Télétransfert point à point
T1	Retard de sécurité d'attente d'une réponse à une requête
XBA	Valeur du champ COM: Réponse à une requête de changement de vitesse
XBR	Valeur du champ COM: Requête de changement de vitesse
ZA1	Champ réservé pour l'authentification bidirectionnelle en programmation
ZA2	Champ réservé pour l'authentification bidirectionnelle en programmation

4 Présentation générale

4.1 Vocabulaire de base

Toute communication fait intervenir deux systèmes désignés par Station Primaire et Station Secondaire. La Station Primaire est le système qui décide d'initialiser une communication avec un système distant désigné Station Secondaire; ces dénominations restent valables pendant toute la durée de vie de la communication.

Une communication est décomposée en un certain nombre de transactions. Chaque transaction se traduit par une émission de l'Émetteur vers le Récepteur. Au cours du déroulement des transactions, les systèmes Station Primaire et Station Secondaire jouent tour à tour le rôle d'Émetteur et de Récepteur.

Dans le cas du profil d'échange de données par bus local avec DLMS ou DLMS/COSEM, les termes Client et Serveur ont le même sens que dans le modèle DLMS (voir l'IEC 61334-4-41 ou l'IEC 62056-5-3). Le Serveur (qui est une Station Secondaire) est le système qui reçoit et traite toute soumission de requête de service particulière. Le Client (qui est une Station Primaire) est le système qui utilise le Serveur dans un but spécifique à l'aide d'une ou de plusieurs requêtes de service.

4.2 Profils, couches et protocoles

4.2.1 Généralités

La présente norme spécifie trois profils de communication, voir Figure 1.

- Profil de base (sans DLMS), voir 4.2.2;
- Profil avec DLMS, voir 4.2.3;
- Profil avec DLMS/COSEM, voir 4.2.4.

La couche physique sur les trois profils est la même à part le fait que le profil avec DLMS/COSEM permet la négociation de la vitesse. Cette couche physique commune permet la coexistence de différents profils sur le même bus.

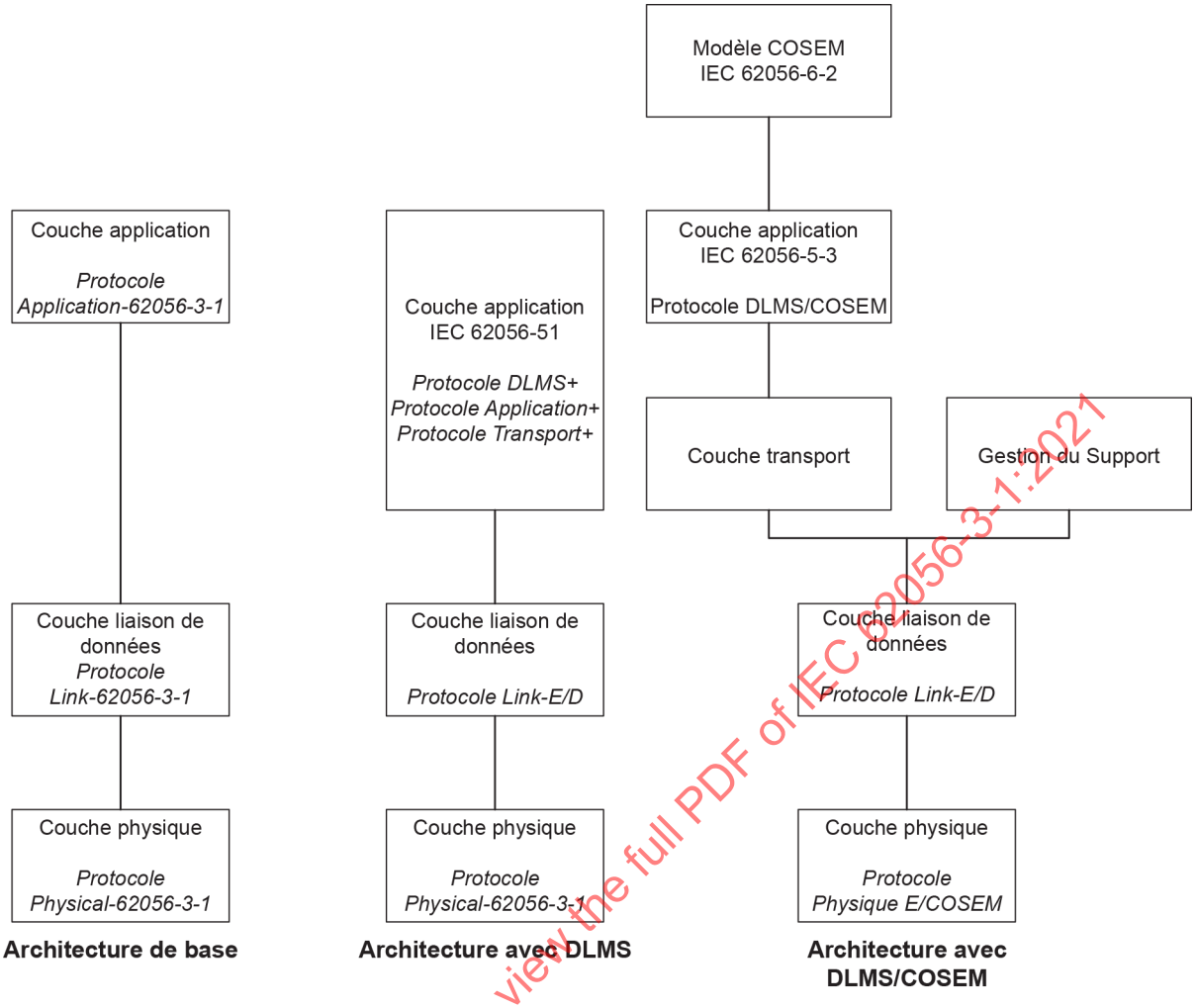


Figure 1 – Profils de communication IEC 62056-3-1

4.2.2 Profil de base (sans DLMS)

Le profil de base (sans DLMS) utilise le protocole à trois couches:

- La couche physique avec le protocole *Physical-62056-3-1* spécifié en 5.1;
- La couche liaison avec le protocole *Link-62056-3-1* spécifié en 5.2;
- La couche application avec le protocole *Application-62056-3-1* spécifié en 5.3.

Ce profil permet le télérelevé et la téléprogrammation, le télétransfert de données point à point (qui est un service simplifié de téléprogrammation), le télétransfert en diffusion, la téléalimentation des stations secondaires, la détection de stations oubliées et les fonctions d'alarme. Les services de communication associés sont spécifiés en 4.4.

4.2.3 Profil avec DLMS

Le profil avec DLMS utilise le protocole à trois couches:

- La même couche physique que le profil de base spécifié en 5.1;
- La couche liaison de données utilisant le protocole *Link-E/D* spécifié en en 6.2 et;
- La couche application spécifiée dans l'IEC 62056-51 utilisant les protocoles *Transport+*, *Application+* et *DLMS+*, voir 6.3.

Ce profil permet aussi l'utilisation de DLMS tel qu'il est spécifié dans l'IEC 61334-4-41. Les services de communication associés sont spécifiés en 4.5.

4.2.4 Profil avec DLMS/COSEM

Le profil avec DLMS/COSEM utilise un protocole à quatre couches:

- La couche physique est similaire à celle utilisée dans le profil de base et dans le profil avec DLMS comme cela est spécifié en 5.1, mais avec une négociation de la vitesse, voir 7.2;
- La couche liaison de données utilise le protocole *Link*-/E/D. Elle est la même que la couche liaison de données dans le profil avec DLMS sauf qu'elle interface la couche gestion du support et la couche transport. Voir 7.3;
- La couche gestion du support prend en charge les processus spécifiques à la gestion du bus, voir 7.4;
- La couche transport met en place la segmentation et le réassemblage des APDU, voir 7.5;
- La couche application, telle qu'elle est spécifiée dans l'IEC 62056-5-3, et prenant en compte quelques spécificités du bus Euridis, voir 7.6.

Le profil DLMS/COSEM permet l'utilisation de la modélisation objet COSEM et des services DLMS d'accessibilité aux objets COSEM, sur le bus Euridis.

4.3 Langage de spécification

Dans le présent document, le protocole de chaque couche est décrit par des transitions d'état représentées sous la forme de tableaux. La syntaxe utilisée pour la constitution de ces tableaux est définie par un langage de spécification présenté à l'Annexe A.

En cas de divergence d'interprétation entre une partie du texte et un tableau de transitions d'état, c'est toujours le tableau qui fait référence.

4.4 Services de communication pour l'échange de données en bus local sans DLMS

4.4.1 Vue d'ensemble

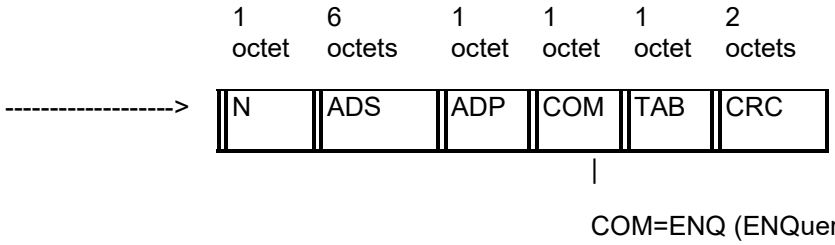
La liste des services disponibles (voir Annexe I) au niveau de la couche Application est:

a) télérelève de données, voir 4.4.2;
b) téléprogrammation de données, voir 4.4.3;
c) télétransfert point à point, qui est un service de téléprogrammation simplifié, voir 4.4.4;
d) télétransfert en diffusion, 4.4.5;
e) initialisation du bus, 4.4.6;
f) appel des stations oubliées, 4.4.7.

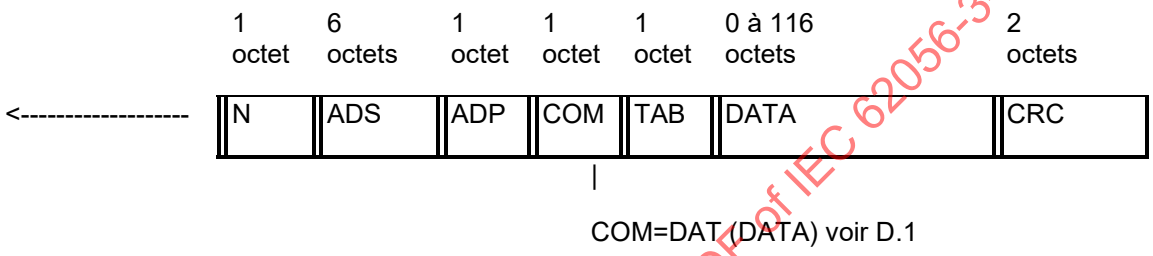
4.4.2 Télérelève

L'échange ENQ est constitué de deux trames en une seule séquence:

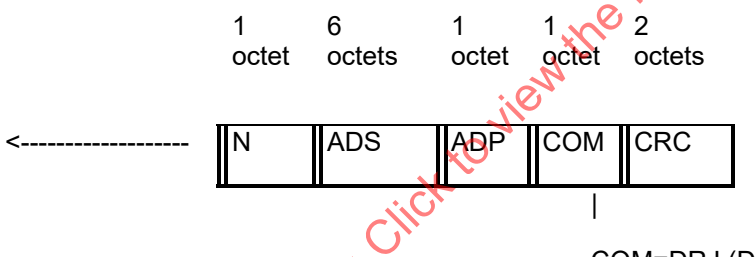
- trame de télérelève qui contient dans le champ TAB le type de données à relever:



- trame d'acquittement positif qui contient les données relevées dans le champ DATA:



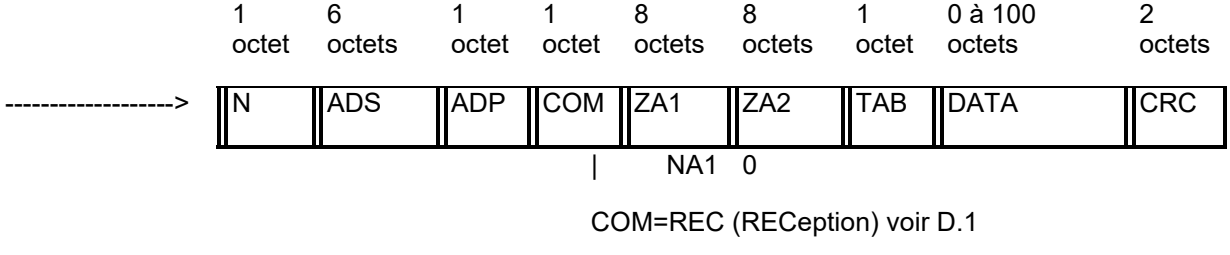
- trame d'acquittement négatif (référence TAB inconnue)



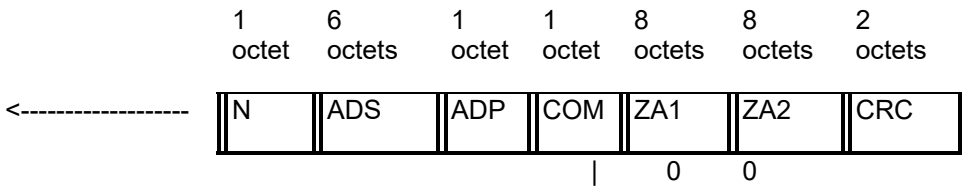
4.4.3 Téléprogrammation

L'échange REC est constitué de quatre trames en deux séquences. Comme il comporte une séquence interne pour l'authentification, il apparaît du point de vue de l'application, comme un échange de deux trames en une seule séquence:

- trame de téléprogrammation qui contient les données à programmer dans le champ DATA et leur référence dans le champ TAB

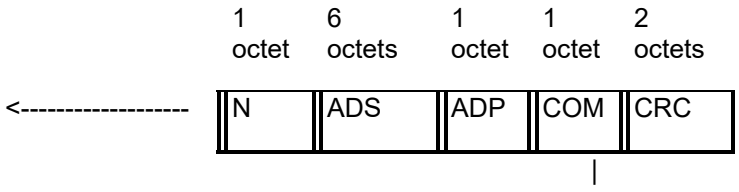


- trame d'acquittement positif (pas de problème d'authentification)



COM=EOS (End Of Session) voir D.1

- trame d'acquittement négatif (pas de problème d'authentification mais les données à téléprogrammer ne sont pas valables)



COM=DRJ (Data ReJected) voir D.1

L'authentification est réalisée par un échange de nombres aléatoires cryptés au moyen d'une clef secrète propre à chaque Station Secondaire. Les nombres aléatoires sont générés avec une taille de 8 octets puis cryptés avec l'algorithme DES, en utilisant une clef Ki sur 8 octets connue des deux stations Primaire et Secondaire.

Un nombre aléatoire NA1 est d'abord généré par la Station Primaire puis transmis dans le champ ZA1 de la trame de téléprogrammation, tandis que le champ ZA2 est positionné sur zéro.

À l'arrivée sur la Station Secondaire, le champ ZA1 est crypté par l'algorithme DES, en utilisant la clef Ki, pour obtenir le nombre aléatoire crypté NA1K. Puis les deux stations échangent les deux trames formant la séquence interne d'authentification.

La première trame (dans le sens Station Secondaire vers Station Primaire) contient le nombre aléatoire NA1K dans le champ ZA1 et un nombre aléatoire NA2 généré par la station Secondaire dans le champ ZA2.

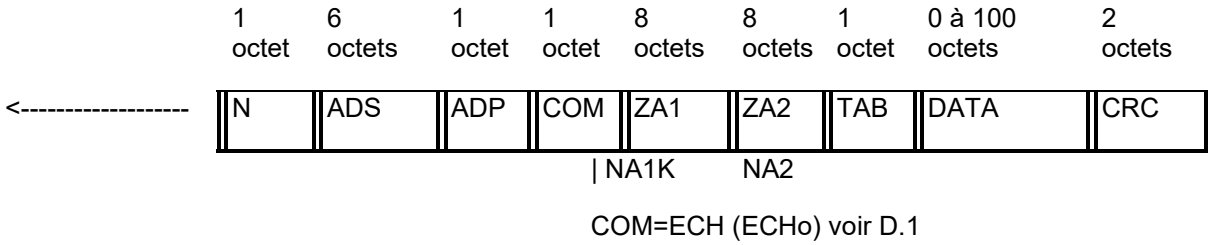
À la réception de cette trame, la Station Primaire compare le contenu du champ ZA1 au nombre NA1' obtenu en cryptant le nombre transmis NA1 au moyen de l'algorithme DES et de sa clef Ki. Si NA1' = ZA1, la Station Primaire considère que la Station Secondaire est bien authentifiée. Sinon, elle considère que la Station secondaire n'est pas authentifiée et coupe la session de communication.

Dans le cas d'une authentification correcte de la Station Secondaire, la Station Primaire crypte d'abord le nombre aléatoire NA2 au moyen de l'algorithme DES et de sa clef Ki, pour obtenir le nombre aléatoire crypté NA2K qu'il transmet ensuite dans le champ ZA2, le champ ZA1 étant positionné sur zéro.

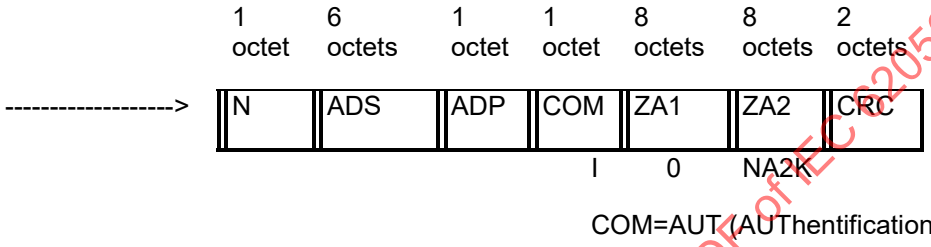
À la réception de cette trame de réponse, la Station Secondaire compare le contenu du champ ZA2 au nombre NA2' obtenu en cryptant le nombre transmis NA2 au moyen de l'algorithme DES et de sa clef Ki. Si NA2' = ZA2, la Station Secondaire considère que la Station Primaire est bien authentifiée. Sinon, elle considère que la Station Primaire n'est pas authentifiée et envoie une trame d'acquittement négatif.

L'échange interne d'authentification est le suivant:

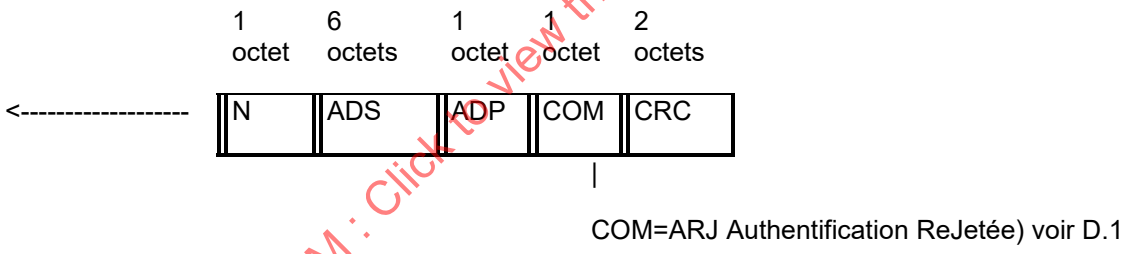
- trame interne d'authentification qui contient le nombre aléatoire crypté NA1K dans le champ ZA1 et le nombre aléatoire NA2 dans le champ ZA2



- trame de réponse positive qui contient le nombre aléatoire crypté NA2K dans le champ ZA2 (si la Station Secondaire est bien authentifiée)



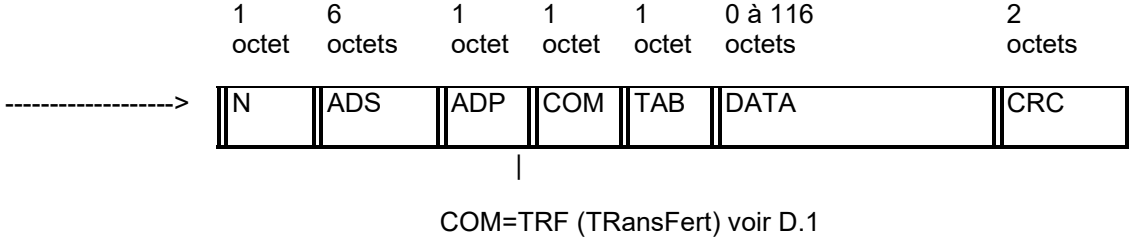
- trame de rejet d'authentification, remplaçant la trame normale EOS ou DRJ lorsque la Station Primaire n'a pas été convenablement authentifiée



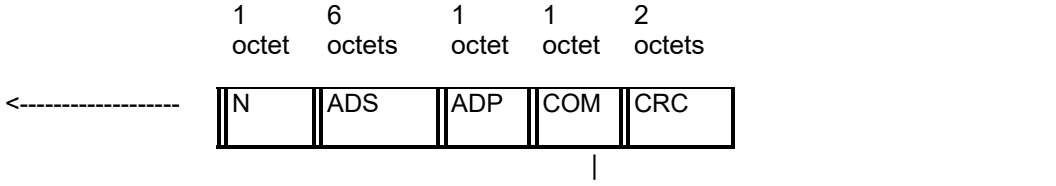
4.4.4 Télétransfert point à point

L'échange TRF est constitué de deux trames en une seule séquence. Du point de vue de l'application, il apparaît comme un échange de téléprogrammation en une seule séquence et sans authentification:

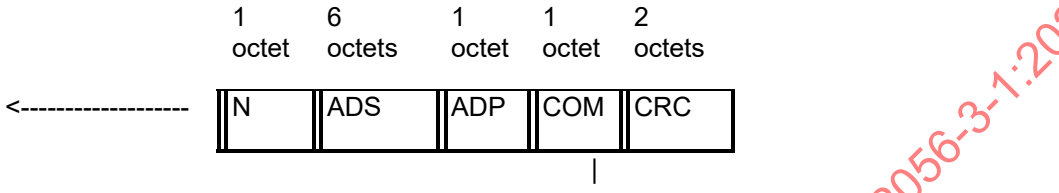
- trame de télétransfert point à point qui contient les données à programmer dans le champ DATA et leur référence dans le champ TAB



- trame d'acquittement positif



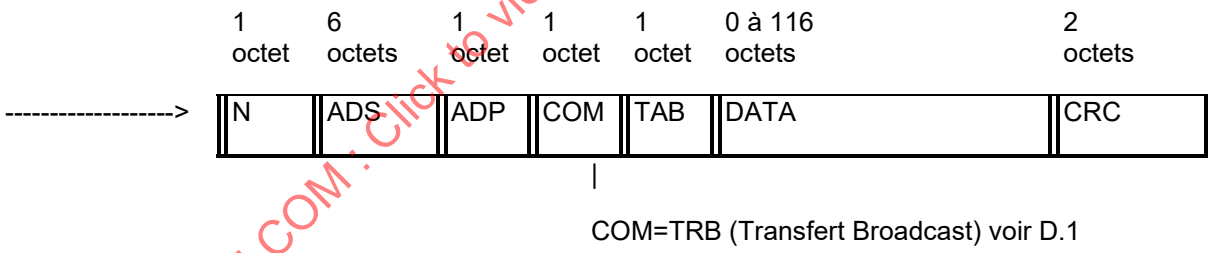
- trame d'acquittement négatif (les données télétransférées ne sont pas valables)



4.4.5 Télétransfert en diffusion

La trame TRB ne comporte pas de trame de réponse. Du point de vue de l'application, il apparaît comme une séquence similaire à celle du télétransfert point à point, mais sans acquittement puisqu'il s'agit d'une diffusion.

- trame de télétransfert en diffusion qui contient les données à programmer dans le champ DATA et leur référence dans le champ TAB

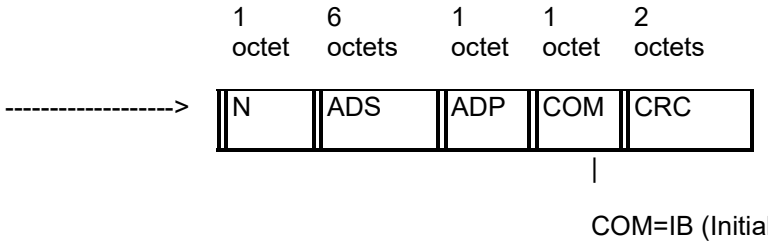


L'adresse secondaire (qui définit les Stations Secondaires destinataires) doit être une adresse de diffusion.

4.4.6 Trame d'initialisation du bus

La trame IB ne comporte pas de trame de réponse. Du point de vue de l'application, elle apparaît comme une trame similaire à celle du télétransfert en diffusion, mais sans données puisqu'il s'agit uniquement de positionner à TRUE (VRAI) le fanion de "station oubliée" pour toutes les Stations Secondaires programmées avec l'adresse ADP:

- Trame d'initialisation du bus



L'adresse secondaire (qui définit les Stations Secondaires destinataires) doit être une adresse de diffusion.

Après le passage d'une trame d'initialisation de bus, toute Station Secondaire recevant une trame ENQ correcte avec une référence TAB connue n'est plus considérée comme une "station oubliée".

4.4.7 Appel des stations oubliées

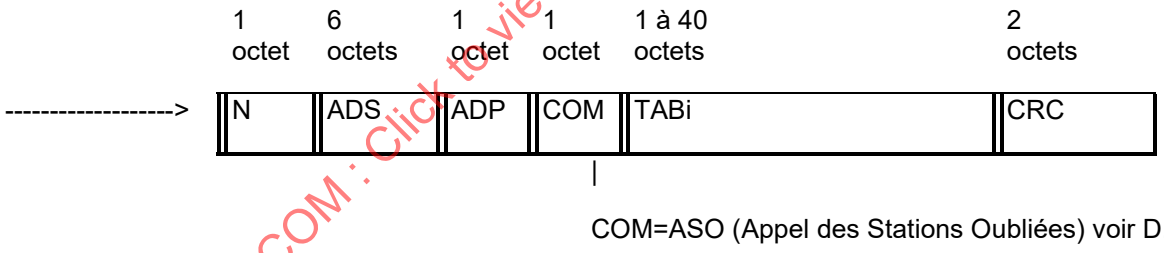
L'échange ASO est constitué de deux trames en une seule séquence. À la fin d'une séquence de télérelève, la Station Primaire peut chercher les stations dont le fanion de "station oubliée" est à TRUE (VRAI) (au plus 5 sur un total de 100).

Étant donné qu'un échange correct de télérelève positionne à FALSE (FAUX) le fanion de "station oubliée" de la station concernée, ce service n'est généralement demandé qu'à la fin d'une séquence de télérelève, formée d'un ou de plusieurs échanges de télérelève précédés d'une trame d'initialisation de bus.

La Station Primaire gère plusieurs intervalles de temps. Lorsqu'elle détecte une collision en retour, elle doit retenter un échange ASO. Chaque fois qu'elle reçoit une réponse correcte d'une Station Secondaire, la Station Primaire doit l'éliminer de la liste des stations oubliées en effectuant une télérelève correcte de cette station.

Afin de respecter les contraintes de sélection (décrites en 4.4.9), les stations téléalimentées doivent répondre dans le premier intervalle de temps du premier échange ASO. Ensuite, seules sont sélectionnées les stations oubliées et le principe habituel peut être utilisé pour les échanges ASO suivants.

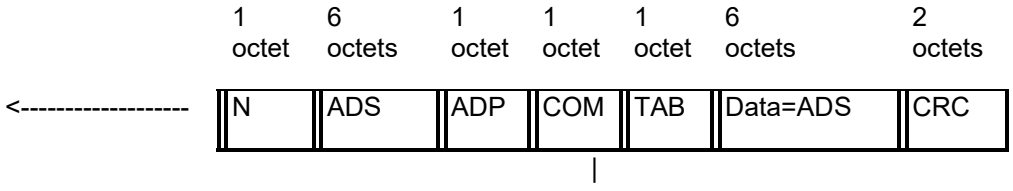
- appel des stations oubliées qui contient des critères de sélection dans le champ TABi (1 à 40 références TAB)



COM=ASO (Appel des Stations Oubliées) voir D.1

Il convient que l'adresse secondaire (qui définit les Stations Secondaires destinataires) soit une adresse de diffusion.

- trame d'acquittement qui contient la première référence TAB reconnue par l'unité, et l'ADS de la station



COM=RSO (Réponse de Station Oubliée) voir D.1

- Le champ de données contient l'ADS de la station secondaire répondant à l'appel des stations oubliées.

4.4.8 Champs de la trame

N nombre total d'octets de la trame, y compris N.

ADS adresse physique absolue de la Station Secondaire codée comme une chaîne de 48 bits. Il y a une seule adresse physique de diffusion, l'adresse générale ADG codée "000000000000" en hexadécimal[1].

L'ADS correspond également au Titre système de la Station Secondaire.

ADP adresse physique de la Station Primaire codée comme une chaîne de 8 bits. La valeur "00" H est réservée au codage de l'adresse physique de l'APG primaire générale [2]. Toute Station Secondaire sollicitée par une Station Primaire dont l'adresse primaire est APG, répond avec la première adresse physique primaire avec laquelle elle a été programmée.

COM code de la commande, dépendant de l'échange et de la direction de la trame (voir l'Annexe D).

ZA1, ZA2 champs réservés pour l'authentification réalisée au cours d'un échange de téléprogramation.

TAB référence des données sélectionnées, associée à certains codes de commande (ENQ, DAT, REC, TRF, TRB ou RSO). La valeur "00" H est réservée à la gestion du système, la valeur "FF" H à la gestion de la fonction alarme.

DATA paquet d'informations provenant de l'application hôte. Ce champ peut être vide en fonction du code de commande.

CRC Champ de contrôle de redondance cyclique qui contient les 16 bits redondants du CRC (*cyclic redundancy check*) dont le principe est décrit à l'Annexe E.

Les champs de la trame sont transmis dans l'ordre croissant (de N au CRC). Lorsqu'un champ contient des données sur plusieurs octets, l'émission commence par l'octet de poids faible, et se termine par l'octet de poids fort. Cependant, le champ DATA est considéré comme une chaîne d'octets et est émis dans un ordre croissant.

4.4.9 Principe de la téléalimentation en énergie

Le principe général qui régit les échanges de données est préservé pour les stations téléalimentées. Il est seulement ajouté une notion de téléalimentation en énergie pour les communications entre une Station Primaire et une ou plusieurs Stations Secondaires.

Pour démarrer une session de communication, il convient que la Station Primaire envoie un "Appel général", qui alerte le système de communication de chaque Station Secondaire connectée au bus. Cet appel correspond à la présence d'une porteuse pendant une durée nominale qui dépend du mécanisme de téléalimentation en énergie:

- la durée du signal d'"Appel général" est AGT pour réveiller les stations téléalimentées;
- la durée du signal d'"Appel général" est AGN pour réveiller les stations alimentées.

Remarque: Une station secondaire peut être configurée en mode alarme. Elle est alors téléalimentée en continu, et peut ainsi transmettre une alarme à la station primaire, voir 4.4.11.

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1 D'autres adresses de diffusion peuvent être définies, en fonction des règles d'adressage adoptées dans les normes d'accompagnement pour la sémantique des Titres système, qui sont souvent fondées sur un code de fabricant, une année de fabrication et un type d'équipement.

2 D'autres adresses générales peuvent être définies, en fonction des règles d'adressage adoptées dans les normes d'accompagnement pour la sémantique des identifiants d'opérateurs, qui sont souvent fondés sur un code fournisseur.

De plus, quel que soit le type de la station distante sélectionnée (alimentée ou non), un “Appel général” AGN intermédiaire doit également être envoyé par la Station Primaire dans les circonstances suivantes:

- avant le premier échange de type ENQ ou TRF;
- avant le sixième échange consécutif et concluant de type ENQ ou TRF avec la même Station Secondaire;
- avant le premier échange de type ENQ ou TRF avec une autre Station Secondaire que celle sélectionnée auparavant, lors du précédent échange de type ENQ ou TRF;
- avant un quelconque échange de type REC;
- avant une trame TRB quelconque;
- avant une trame IB quelconque;
- avant un quelconque échange de type ASO.

Cela permet à la Station Primaire de ne pas réveiller toutes les stations distantes téléalimentées si ce n’est pas nécessaire, et ainsi de sauvegarder l’énergie.

Une Station Primaire peut utiliser un modem spécifique assurant à la fois la téléalimentation en énergie, et les fonctions de modulation-démodulation. La durée de communication et le nombre de stations téléalimentées doivent être optimisés pour sauvegarder les batteries de la Station Primaire.

Dans le cas où la Station Primaire ne peut réaliser que les fonctions de modulation-démodulation, une station auxiliaire fournit en continu l’énergie sur le bus.

Une Station Secondaire, qui peut être alimentée ou non, ne contient généralement qu’une seule application logique, référencée par son ADS.

Il convient qu'une Station Secondaire multiple (qui contient plusieurs applications logiques, correspondant à plusieurs ADS) soit une station téléalimentée. Ce type de station est décrit plus complètement à l’Article 8.

4.4.10 Présélection d’une station téléalimentée

Pour optimiser la consommation sur le bus, un échange de présélection permet à la Station Primaire de sélectionner une Station Secondaire téléalimentée.

L’échange de présélection est réalisé après un “Appel général” AGT adressé à toutes les stations téléalimentées présentes sur le bus. Pour limiter la consommation sur le bus, il convient que la première trame envoyée par la Station Primaire soit suffisamment courte, et il convient que la Station Secondaire concernée réponde avant le déclenchement du temps de réveil TOPRE. Le modem de la Station Secondaire retourne dans un état de basse consommation s’il ne détecte pas de réponse dans le temps imparti.

Durant l’échange de présélection, toutes les stations téléalimentées consomment de l’énergie. La tension sur le bus et l’énergie stockée décroissent jusqu’à ce que les stations non sélectionnées retournent à un état de basse consommation. Puis l’envoi continu d’énergie charge les éléments de stockage d’énergie et augmente la tension sur le bus.

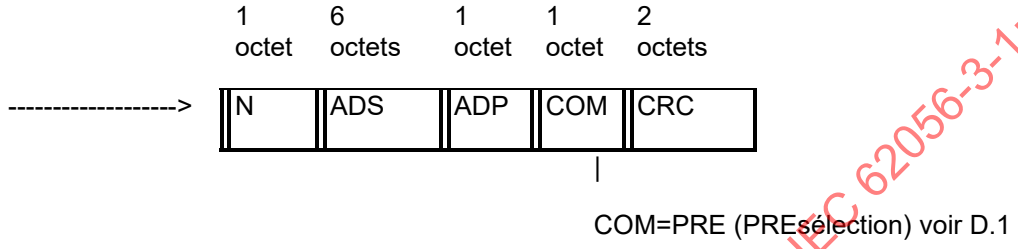
Il convient que le modem de la Station Primaire ait accumulé assez d’énergie avant la première présélection. Cette étape est assurée par un temps d’attente contrôlé par le temps de réveil TICB. A la fin de la présélection, les éléments de stockage d’énergie sont vides et la Station Primaire doit attendre la remontée de la tension sur le bus avant de réaliser une deuxième présélection.

La trame de présélection doit avoir une taille maximale de 18 octets, elle peut correspondre à:

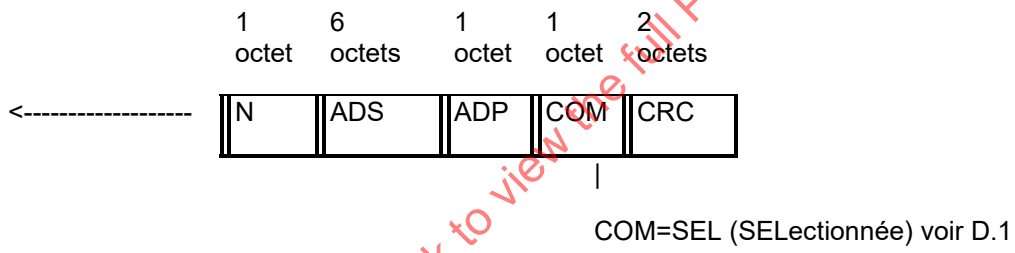
- une trame ENQ;
- une trame TRB ou TRF, si et seulement si le champ DATA a une taille inférieure ou égale à 6 octets;
- une trame IB;
- une trame ASO, si et seulement si le nombre de champs TABi est inférieur ou égal à 7.

Comme la première trame d'un échange de type REC ou TRF peut être trop grande, un service supplémentaire est fourni pour la présélection. Cet échange de présélection complètement transparent est formé d'une séquence de deux trames.

- Trame de présélection d'une station téléalimentée



- trame d'acquittement



Pour préserver l'énergie de la Station Primaire, il n'y a pas de reprise lors d'un échange de présélection. Si une station téléalimentée ne répond pas correctement, elle n'est pas sélectionnée, et la Station Primaire doit envoyer un nouveau signal "Appel général" AGT.

4.4.11 Communication après la présélection

Après la présélection, le modem d'une station téléalimentée peut rester réveillé tout le long de la communication. Les délais ne sont plus essentiels puisque le nombre de dispositifs connectés est limité. La Station Primaire alimente la station sélectionnée et charge les accumulateurs des stations non sélectionnées.

La session de communication se termine différemment selon le mécanisme de téléalimentation en énergie:

- après une courte période d'inactivité au cours de la session de communication, lorsqu'aucun "Appel général" AGN intermédiaire n'est pas exigé pour les stations alimentées. Cette période est contrôlée par le temps de réveil TOL;
- après une période d'inactivité plus longue durant la session de communication, pour une station téléalimentée. Cette période est contrôlée par le temps de réveil TOAG.

Noter que, pour une station téléalimentée, un signal "Appel général" intermédiaire AGN est suffisant pour poursuivre la session de communication courante tant qu'il n'y a pas eu déclenchement du temps de réveil TOAG.

4.4.12 Fonction Alarme

Un dispositif intégré dans une station secondaire simple ou multiple (voir 8.2.3) peut transmettre des alarmes à une station primaire, à condition de pouvoir intégrer les fonctions d'interface définies ci-dessous.

Une alarme doit être récupérée sur la station secondaire dans les 10 s au plus.

Une configuration programmable sur l'Interface et sur chaque dispositif, permet de choisir le mode Alarme: actif ou inactif.

Lorsque le mode Alarme est actif, le dispositif à l'intérieur de la station secondaire peut générer une alarme. La fonction alarme n'est effective que si l'alimentation en énergie est présente et permanente sur le bus.

Le dispositif envoie le signal d'alarme pendant un délai TASB. TASB est suffisamment long pour forcer à un état "0" le bus secondaire et être détecté par l'Interface, même s'il y a une communication en cours.

Le mécanisme d'alarme est décrit à la Figure 2.

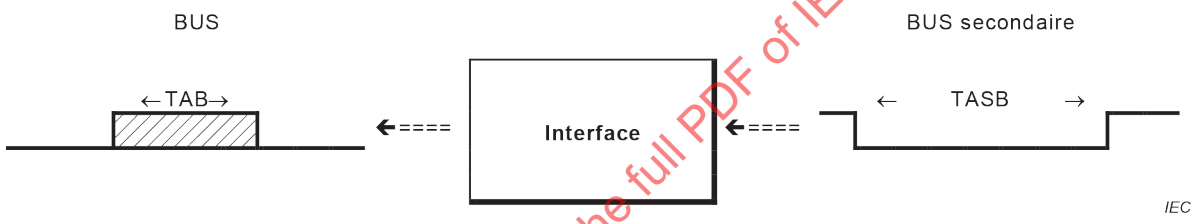


Figure 2 – Mécanisme d'alarme

L'alarme n'est pas directement transmise vers la station primaire. Elle est reçue par l'Interface qui la retransmet en envoyant un "0" (porteuse à 50 kHz) durant TAB sur le bus, dès que c'est possible:

a) Aucune communication sur le bus.

   Lorsque l'Interface reçoit l'alarme en provenance du bus secondaire, elle la retransmet sur le bus.

b) En se synchronisant sur un AGN ou un AGT si une communication est en cours. Lorsqu'une communication est en cours sur le bus, l'Interface mémorise l'alarme reçue. Elle la retransmet sur le bus après l'un des événements suivants:

   - TOALR après la fin de la réception d'un AGN ou d'un AGT;
   - à la fin normale de la session de communication.

Ainsi, l'Interface peut filtrer les alarmes pour éviter les conflits sur le bus.

Après la génération d'une alarme, la Station Secondaire est considérée comme une "station oubliée" avec un critère de sélection égal à FF.

La Station Primaire configurée en mode Alarme écoute le bus en l'absence de communication sur le bus et après l'émission d'un AGN ou d'un AGT pour détecter la présence d'une alarme. Après la réception d'une alarme, une Station Primaire effectue une procédure d'appel des stations oubliées, avec un critère de sélection du champ TABi égal à FF (voir 4.4.7).

La gestion des alarmes est présentée en 5.1.3 par les diagrammes de temps.

4.5 Services de communication pour l'échange de données par bus local avec DLMS

DLMS ne propose pas de services permettant l'initialisation du bus et l'appel des stations oubliées. Néanmoins, la trame IB et l'échange ASO sont pris en charge et gérés comme pour l'échange de données par bus local sans DLMS. La seule différence est liée au fait que le fanion de station oubliée est considéré comme une variable globale partagée avec l'interface de programmation de l'application.

La télérelève et le télétransfert en point à point sont réalisés directement par DLMS. Mais la téléprogrammation de données (redondante) n'est pas prise en charge puisque l'authentification est réservée à la couche *Application*.

Étant donné que la sémantique des données est gérée par DLMS, le format des trames est très simple, et ne nécessite que des trames banalisées. Pour assurer la compatibilité avec le profil sans DLMS, le format des trames est défini à l'aide des neuf champs suivants:

1 octet	6 octets	1 octet	3 bits	1 bit	2 bits	2 bits	0 à 117 octets	2 octets
Size	ADS	ADP	DATA+	Priority	Send	Confirm	Text	CRC

Size nombre total d'octets de la trame, incluant Size. Si ce nombre diffère de 11, le récepteur sait que la trame contient des données dans le champ Text

ADS même signification que pour le profil en bus local sans DLMS

ADP même signification que pour le profil en bus local sans DLMS

DATA+ toujours codé "111" B

Priority niveau de priorité d'émission de la trame courante. La couche *Application* met la priorité en fonction du service demandé

Send numéro de la dernière trame envoyée

Confirm numéro de la dernière trame reçue sans erreur

Text DSDU (*Data link Service Data Unit*) du niveau supérieur. Une trame ne contient pas nécessairement du texte. Si des données en provenance de la couche *Application* sont disponibles au moment de l'envoi de la trame, elles sont mises dans le champ *Text*, autrement celui-ci est vide. Cela permet l'émission symétrique et bidirectionnelle des données. Afin de ne pas confondre les trames de type DATA+ avec les trames du profil sans DLMS, les champs DATA+, Priority, Send et Confirm correspondent à un code de commande spécial, COM, dont les valeurs sont différentes de celles déjà réservées pour le champ COM (voir l'Annexe D)

CRC même signification que pour le profil en bus local sans DLMS

Les champs de la trame sont émis dans l'ordre croissant (de Size au CRC). Lorsqu'un champ est codé sur plusieurs octets, l'émission commence par l'octet de poids faible, et se termine par l'octet de poids fort. Cependant, le champ Text est considéré comme une chaîne d'octets et est émis dans un ordre croissant.

4.6 Gestion du système

La gestion du système a pour objet de permettre un enrôlement qui comporte l'identification des stations secondaires sur un bus. Le service Discover est prévu à cet effet.

L'enrôlement consiste en une séquence de demandes Discover effectuée par l'initiateur actif situé dans la Station Primaire. Chaque service Discover sert à informer les nouvelles stations restantes qu'elles ont une possibilité de répondre durant les prochains intervalles de temps.

La demande Discover contient un paramètre correspondant à une probabilité de réponse spécifique. Ce paramètre est un entier compris dans la plage [0, 100]. Il traduit la probabilité de réponse d'une nouvelle station en pourcentage. Lorsqu'il est mis à 100, toutes les nouvelles stations sur le bus doivent répondre.

Sur réception d'une indication Discover, chaque Station Secondaire vérifie la valeur de son fanion Discovered. S'il est égal à TRUE (VRAI), l'indication est supprimée; sinon la station tire un nombre aléatoire entre 1 et 100. Si ce nombre est plus petit ou égal au paramètre de probabilité de réponse, la nouvelle station répond au Discover et met son fanion Discovered à TRUE (VRAI).

La réception d'une trame IB réinitialise toujours le fanion Discovered.

Pour assurer une compatibilité maximale (aussi bien pour les stations DLMS ou DLMS/COSEM que pour les autres), il est proposé de mettre en œuvre le service de gestion du système conformément à ce qui est indiqué à l'Annexe H.

5 Échange de données par bus local sans DLMS

5.1 Couche Physique

5.1.1 Protocole Physical-62056-3-1

Le protocole *Physical-62056-3-1* de la couche *Physique* du profil d'échange de données par bus local sans DLMS adopte un comportement asymétrique. Le diagramme d'états de la Station Primaire est donc différent de celui de la Station Secondaire.

Le protocole *Physical-62056-3-1* prend en charge les Stations Secondaires téléalimentées ou non. Ainsi qu'il est indiqué dans la description générale, les stations distantes sont réveillées par un signal "Appel général", de type AGN ou AGT, et une session de communication se termine à l'expiration du temps de réveil TOL ou TOAG.

Après un signal "Appel général", une session de communications se déroule en asynchrone et en semi-duplex à 1 200 bits/s sur le bus.

5.1.2 Paramètres de physique

La valeur de la taille maximale MaxIndex d'une trame en réception est fixée à 128.

La valeur du nombre maximal MaxRSO d'intervalles de temps RSO pour le traitement d'une trame "Appel des Stations Oubliées" est fixée à 3.

La durée du signal "Appel général" AGN doit être dans la plage [50, 150[ms, tandis que celle du signal "Appel général" AGT doit être dans la plage [200, 300[ms.

Les caractéristiques et les types des temporisations sont donnés à l'Annexe B.

Les valeurs données dans le Tableau 1 sont définies pour une Station Primaire.

Tableau 1 – Temporisation d'une Station Primaire

	Min. ms	Nominal ms	Max. ms	Type voir B.1	Définition
TA10	–	–	120	TSL1	Temps d'attente maximal du premier octet d'une trame en réception
TAB		100		TC	Durée d'un signal d'alarme sur le bus
TAGN	–	100	–	TPDF	Durée d'un signal "Appel général" AGN
TAO	–	–	40	TC	Temps d'attente maximal d'un octet en réception dont l'expiration indique la fin d'une trame
TARSO	–	500	–	TC	Durée d'un intervalle de temps pour le RSO
TASB		1 200		TC	Temps d'attente après le début d'un signal d'alarme
TEMPO	–	40	–	TC	Retard de sécurité en fin d'émission d'un signal "Appel général" ou d'une trame
TOE	–	–	2 500	TL	Retard de sécurité en émission pour se protéger contre un défaut matériel
TOL	–	–	100	TSL2	Temps d'attente maximal d'une requête issue de la couche supérieure
T1	_	10 000	_	TL	Temps d'attente maximal d'une réponse de la station secondaire
Spécifique d'une station téléalimentée (Alimentation)					
TAGT	–	250	–	TPDF	Durée d'un signal "Appel général" AGT
TICB	8 000	–	–	Ta	Délai initial de chargement du bus
TOAG	–	–	3 000	TPFD	Retard maximal pour une station téléalimentée sélectionnée, pour reconnaître un signal "Appel général" AGN

Les valeurs données dans le Tableau 2 sont définies pour une Station Secondaire.

Tableau 2 – Temps d'une Station Secondaire

	Min. ms	Nominal ms	Max. ms	Type[a]	Définition
TA1O	30 [b]	–	160	TSL1	Temps d'attente maximal du premier octet d'une trame en réception
TAB		100	–	TC	Durée d'un signal d'alarme sur le bus
TAGN	50	100	150	TPDF	Durée d'un signal "Appel général" AGN
TAO	–	–	40	TC	Temps d'attente maximal d'un octet d'une trame en réception dont l'expiration indique la fin d'une trame
TARSO	–	–	500	TC	Durée d'un intervalle de temps pour le RSO
TOALR	20	–	–	TL	Attente avant l'envoi d'un AGN après la réception d'un AGN ou d'un AGT
TOE	–	–	2 500	TL	Retard de sécurité en émission pour se protéger contre un défaut matériel
TOL	–	–	100	TSL2	Temps d'attente maximal d'une requête issue de la couche supérieure
Spécifique d'une station téléalimentée (Alimentation)					
TAGT	200	250	300	TPDF	Durée d'un signal "Appel général" AGT
TASB	–	1 200	–	TL	Durée d'un signal d'alarme sur le bus secondaire
TICB	8 000	–	–	Ta	Délai initial de chargement du bus
TOAG	–	–	3000	TPFD	Retard maximal pour une station téléalimentée sélectionnée, pour reconnaître un signal "Appel général" AGN
TOAGN	–	–	300	Tc	Retard d'inactivité maximal pour reconnaître la fin d'une session de communication avec une station téléalimentée
TOAPPEL	–	–	180	TPFD	Temps d'attente maximal de réception du premier octet d'une trame de présélection
TOBAVARD	–	–	260	TPDF	Retard de sécurité pour se protéger contre les trames de présélection défectueuses
TOPRE	–	–	130	TPFD	Temps d'attente maximal de la réponse à une présélection
TOSEUIL	–	150	–	TC	Durée d'un signal "Appel général" qui réveille une station téléalimentée
TVASB	40	–	–	TL	Durée minimale d'un signal d'alarme sur le bus secondaire

[a] Pour la définition des différents types de temporisations, voir Article B.1.

[b] Après un "Appel général", une durée minimale de 30 ms est nécessaire.

5.1.3 Diagrammes de temps

Les Figure 3, Figure 4 et Figure 5 peuvent être utilisées pour représenter différents types de sessions du protocole pour les stations secondaires téléalimentées.

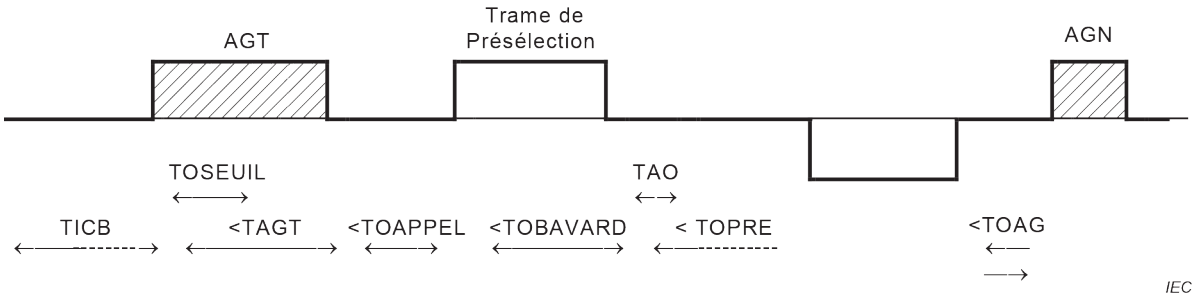


Figure 3 – Échanges sans interruption

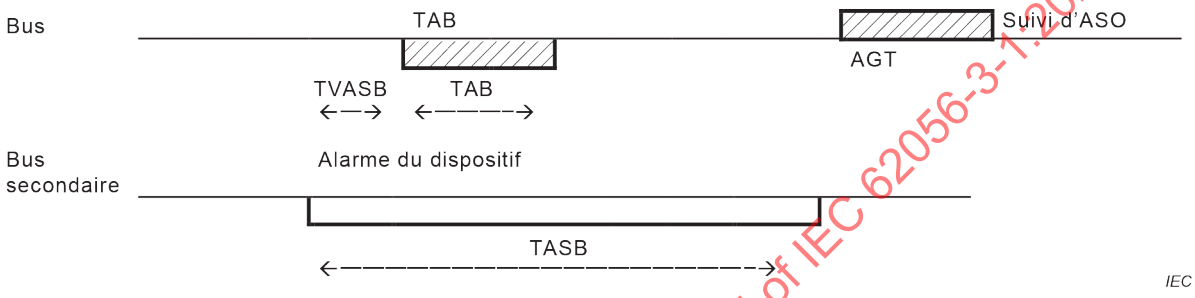


Figure 4 – Alarme sans aucune communication en cours

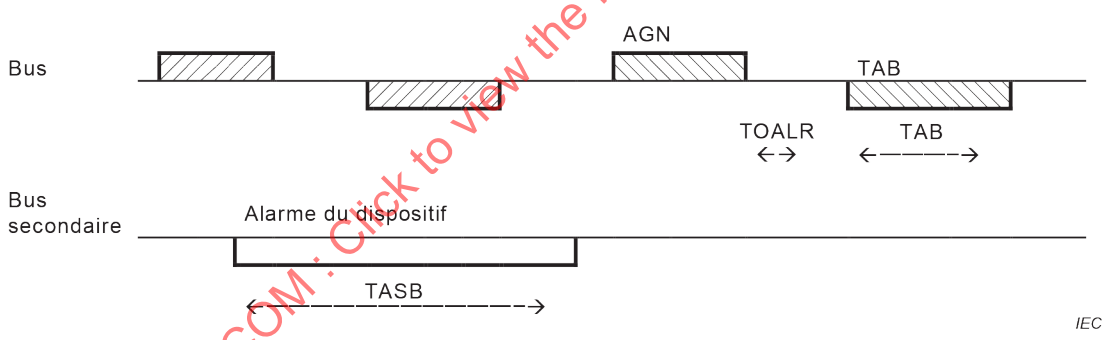


Figure 5 – Alarme avec une communication en cours

5.1.4 Services et primitives de service de physique

L'utilisateur du protocole *Physical-62056-3-1* peut utiliser les services et primitives de service indiqués dans le Tableau 3.

Tableau 3 – Services et primitives de services de physique

Service	Primitive de service
Phy_DATA	Phy_DATA.req(Frame) Phy_DATA.ind(Frame)
Phy_UNACK	Phy_UNACK.req(Frame)
Phy_APPG	Phy_APPG.req(TypeAG) Phy_APPG.ind()
Phy_ASO	Phy_ASO.req(Frame) Phy_ASO.ind(Frame)
Phy_RSO	Phy_RSO.req(Frame, Window)
Phy_COLL	Phy_COLL.ind()
Phy_ALARM	Phy_ALARM.req() Phy_ALARM.ind()
Phy_ABORT	Phy_ABORT.req() Phy_ABORT.ind(ErrorNb)

Le rôle attribué à chaque primitive est le suivant:

- Phy_DATA.req(Frame) permet à la couche *Liaison de données* de demander à la couche *Physique* l'émission d'une trame Frame;
- Phy_DATA.ind(Frame) permet à la couche *Physique* d'informer la couche *Liaison de données* qu'une trame Frame est disponible;
- Phy_UNACK.req(Frame) permet à la couche *Liaison de données* de demander à la couche *Physique* l'émission d'une trame Frame sans attendre d'acquittement;
- Phy_APPG.req(TypeAG) permet à la couche *Liaison de données* de demander à la couche *Physique* l'émission d'un signal "Appel général". La durée TypeAG du signal est soit AGN soit AGT;
- Phy_APPG.ind() permet à la couche *Physique* d'informer la couche *Liaison de données* de la fin d'émission d'un signal "Appel général";
- Phy_ASO.req(Frame) permet à la couche *Liaison de données* de demander à la couche *Physique* l'émission d'une trame "Appel des Stations Oubliées";
- Phy_ASO.ind(Frame) permet à la couche *Physique* d'informer la couche *Liaison de données* qu'une trame Frame a été reçue au cours de l'un des intervalles de temps des stations oubliées;
- Phy_RSO.req(Frame, Window) permet à la couche *Liaison de données* de demander à la couche *Physique* l'émission d'une trame Frame d'Appel des Stations Oubliées dans le numéro d'intervalle de temps Window;
- Phy_COLL.ind() permet à la couche *Physique* d'informer la couche *Liaison de données* qu'une collision a été détectée au cours de l'un des intervalles de temps des stations oubliées;
- Phy_ALARM.req() permet à la couche *Liaison de données* de demander à la couche *Physique* l'émission d'une Alarme;
- Phy_ALARM.ind() permet à la couche *Physique* d'informer la couche *Liaison de données* de l'arrivée d'une alarme;
- Phy_ABORT.req() permet à la couche *Liaison de données* de demander à la couche *Physique* de mettre fin à son activité;
- Phy_ABORT.ind(ErrorNb) permet à la couche *Physique* d'informer la couche *Liaison de données* de l'occurrence d'une erreur fatale repérée par le numéro ErrorNb.

5.1.5 Transitions d'état

Les transitions d'état de *Physical-62056-3-1* sont indiquées dans le Tableau 4, le Tableau 5, le Tableau 6, le Tableau 7 et le Tableau 8.

Tableau 4 – Transitions d'état de *Physical-62056-3-1*: Station Primaire

État initial	Condition de déclenchement	Ensemble d'actions	État final
Initial	$true()	MaxRSO=3 MaxIndex=128 Collision=FALSE SessionAGT=FALSE wait_time(TICB)	Stopped
Stopped	Phy_APPG.req(AG) & AG=AGN	stop_timer(TOAG) FlagAbort=FALSE TypeAG=AGN send_AG(TypeAG)	W.AG
Stopped	Phy_APPG.req(AG) & AG=AGT	SessionAGT=TRUE FlagAbort=FALSE TypeAG=AGT send_AG(TypeAG)	W.AG
Stopped	time_out(TOAG)	Phy_ABORT.ind(EP-2) SessionAGT=FALSE	Stopped
Stopped	Phy_ABORT.req()	$none()	Stopped
Stopped	data-carrier_on	init_timer(TAB) init_timer (TASB)	W.ETABS
W.ETABS	data_carrier_off	stop_timer(TASB) stop_timer(TAB)	Stopped
W.ETABS	time_out(TAB)	Phy_ABORT.ind(EP-3) Phy_ALARM.ind()	W.TASB
W.AG	AG_sent_event	Phy_APPG.ind() init_timer(TEMPO)	W.TAB
W.AG	Phy_ABORT.req()	FlagAbort=TRUE	W.AG
W.TAB	data-carrier_on	Carrier = TRUEinit_timer(TAB) init_timer (TASB)	W.TAB
W.TAB	data-carrier_off	Carrier = FALSE stop_timer(TAB) stop_timer (TASB)	W.TAB
W.TAB	time_out(TEMPO) & not(FlagAbort) & not(Carrier)	init_timer(TOL)	M.Send
W.TAB	time_out(TEMPO) & FlagAbort & not(Carrier)	wait_time (TOL)	*T.Session*
W.TAB	time_out(TEMPO) & Carrier	init_timer(TOL)	W.ETAB
W.TAB	Phy_ABORT.req()	FlagAbort=TRUE	W.TAB
W.ETAB	time_out(TAB)	Phy_ABORT.ind(EP-3) Phy_ALARM.ind() stop_timer(TOL)	W.TASB
W.ETAB	data_carrier_off & not(FlagAbort)	stop_timer(TAB) stop_timer (TASB)	M.Send
W.ETAB	data_carrier_off & FlagAbort	stop_timer(TAB) stop_timer (TASB)	W.TOL
W.ETAB	Phy_ABORT.req()	FlagAbort=TRUE	W.ETAB
W.TASB	time_out(TASB)	$none()	Stopped
W.TOL	time_out(TOL)	$none()	*T.Session*
M.Send	Phy_DATA.req(Frame)	Service=NORMAL	*SendFirst*
M.Send	Phy_UNACK.req(Frame)	Service=UNACKNOWLEDGED	*SendFirst*
M.Send	Phy_ASO.req(Frame)	Service=ASO	*SendFirst*

État initial	Condition de déclenchement	Ensemble d'actions	État final
M.Send	Phy_ABORT.req()	$none()	M.Send
M.Send	time_out(TOL)	$none()	*T.Session*
T.Session	SessionAGT=TRUE	init_timer(TOAG) Phy_ABORT.ind(EP-1) wait_time(TEMPO)	Stopped
T.Session	SessionAGT=FALSE	Phy_ABORT.ind(EP-1) wait_time(TEMP0)	Stopped
SendFirst	$true()	stop_timer(TOL) Size=size(Frame) Index=1 send_octet(Frame, Index) Size=Size-1 init_timer(TOE)	Sending
Sending	octet_sent_event & Size>0	Index=Index+1 send_octet(Frame, Index) Size=Size-1	Sending
Sending	octet_sent_event & Size=0	stop_timer(TOE) wait_time(TAO) Index=1 Frame=""	*Answer*
Sending	Phy_ABORT.req()	stop_timer(TOE) wait_time(TAO) init_timer(TA1O) FlagAbort=TRUE	M.Rec
Sending	time_out(TOE)	Phy_ABORT.ind(EP-3F) wait_time(TAO) init_timer(TA1O) FlagAbort=TRUE	M.Rec
Answer	Service=NORMAL I Service=UNACKNOWLEDGED	init_timer(TA1O)	M.Rec
Answer	Service=ASO	WinRSO=1 init_timer(TARSO) init_timer(TA1O)	M.Rec
M.Rec	octet_received_event	stop_timer(TA1O) Index=Index+1 read_data(RecB) concat(Frame, RecB) init_timer(TAO)	Receiving
M.Rec	collision_detected_event	stop_timer(TA1O) Collision=TRUE init_timer(TAO)	Receiving
M.Rec	time_out(TA1O)	$none()	*Received*
M.Rec	Phy_ABORT.req()	FlagAbort=TRUE	M.Rec
Receiving	octet_received_event & Index<=MaxIndex	stop_timer(TAO) Index=Index+1 read_data(RecB) concat(Frame, RecB) init_timer(TAO)	Receiving
Receiving	octet_received_event & Index>MaxIndex	Phy_ABORT.ind(EP-4F) wait_time(TAO) FlagAbort=TRUE	*Received*
Receiving	collision_detected_event	stop_timer(TAO) Collision=TRUE init_timer(TAO)	Receiving
Receiving	time_out(TAO)	$none()	*Received*
Receiving	time_out(TARSO)	Phy_ABORT.ind(EP-5F) wait_time(TAO) FlagAbort=TRUE	*Received*
Receiving	Phy_ABORT.req()	Flagabort = TRUE	Receiving

État initial	Condition de déclenchement	Ensemble d'actions	État final
Received	Service=NORMAL & not(Flagabort)	Phy_DATA.ind(Frame) init_timer(TOL)	M.Send
Received	(Service=NORMAL & Flagabort) | Service=UNACKNOWLEDGED	wait_time(TOL)	*T.Session*
Received	Service=ASO & Collision & not(Flagabort)	Phy_COLL.ind() Collision=FALSE	*T.RSO*
Received	Service=ASO & not(Collision) & not(Flagabort)	Phy_ASO.ind(Frame)	*T.RSO*
Received	Service=ASO & Flagabort	$none()	*T.RSO*
T.RSO	(TypeAG=AGT) I (WinRSO>=MaxRSO) & (TypeAG=AGN)	stop_timer(TARSO)	*T.Session*
T.RSO	(WinRSO<MaxRSO) & (TypeAG=AGN)	Index=1 Frame=""	W.RSO
W.RSO	time_out(TARSO)	WinRSO=WinRSO+1 init_timer(TARSO) init_timer(TA1O)	M.Rec
W.RSO	Phy_ABORT.req()	Flagabort=TRUE	W.RSO

Tableau 5 – Transitions d'état de la gestion d'alimentation en énergie (Station Secondaire téléalimentée seulement)

État initial	Condition de déclenchement	Ensemble d'actions	État final
Initial	alarm_detection()	Flagalarm = TRUE FlagSendAlarm =FALSE station_power(ON)	Stopped
Initial	not(alarm_detection())	Flagalarm = FALSE	Stopped
Stopped	occur(cpt_carrier_on) & Flagalarm	init_timer(TVASB)	W.TVASB2
Stopped	occur(data_carrier_on)	init_timer(TOSEUIL) init_timer(TAGT)	W.TOSEUIL
W.TOSEUIL	time_out(TOSEUIL)& not(Flagalarm)	station_power(ON)	W.AGT
W.TOSEUIL	occur(data_carrier_off) & not(Flagalarm)	stop_timer(TOSEUIL) stop_timer(TAGT)	Stopped
W.TOSEUIL	time_out(TOSEUIL) & Flagalarm	station_signal(ON) Tend = TOAG	W.AGT
W.TOSEUIL	occur(data_carrier_off) & Flagalarm	stop_timer(TOSEUIL) stop_timer(TAGT) Tend = TOAGN init_timer(Tend)	Hide
W.TOSEUIL	occur(cpt_carrier_on) & Flagalarm	init_timer(TVASB)	W.TVASB1
W.AGT	occur(data_carrier_off)	stop_timer(TAGT) init_timer(TOAPPEL)	W.Sel
W.AGT	time_out(TAGT) & not(Flagalarm)	station_power(OFF)	Stopped
W.AGT	time_out(TAGT) & Flagalarm	init_timer(Tend)	Hide
W.Sel	occur(octet_received_event)	stop_timer(TOAPPEL) init_timer(TOBAVARD) init_timer(TAO)	Select
W.Sel	time_out(TOAPPEL) & not(Flagalarm)	station_power(OFF)	Stopped
W.Sel	time_out(TOAPPEL) & Flagalarm	station_signal(OFF)	Stopped
W.Sel	occur(cpt_carrier_on) & Flagalarm & not(FlagSendalarm)	init_timer(TVASB)	W.TVASB1
Select	occur(octet_received_event)	stop_timer(TAO) init_timer(TAO)	Select
Select	time_out(TAO)	stop_timer(TOBAVARD) init_timer(TOPRE)	W.Answer
Select	time_out(TOBAVARD) & not(Flagalarm)	stop_timer(TAO) station_power(OFF)	Stopped
Select	time_out(TOBAVARD) & Flagalarm	stop_timer(TAO) init_timer(Tend)	Hide
W.Answer	occur(octet_sent_event)	stop_timer(TOPRE) init_timer(Tend)	Hide
W.Answer	time_out(TOPRE) & not(Flagalarm)	station_power(OFF)	Stopped
W.Answer	time_out(TOPRE) & Flagalarm	init_timer(Tend)	Hide
W.Answer	occur(cpt_carrier_on) & Flagalarm & not(FlagSendalarm)	init_timer(TVASB)	W.TVASB1
Hide	occur(octet_received_event) |occur(octet_sent_event) I (occur(data_carrier_on) & not(FlagSendAlarm))	stop_timer(Tend) init_timer(Tend)	Hide
Hide	occur(data_carrier_on) & FlagSendAlarm	stop_timer(Tend)	W.AGend
Hide	time_out(Tend) & not(Flagalarm)	station_power(OFF)	Stopped
Hide	time_out(Tend) & Flagalarm & not(FlagSendAlarm)	station_signal(OFF)	Stopped
Hide	time_out(Tend) & Flagalarm & FlagSendAlarm	Send_AG(AGN)	W.AB
Hide	occur(cpt_carrier_on) & Flagalarm & not(FlagSendalarm)	init_timer(TVASB)	W.TVASB1
W.AGend	occur(data_carrier_off)	wait_time(TOALR) Send_AG(AGN)	W.AB

État initial	Condition de déclenchement	Ensemble d'actions	État final
W.TVASB1	occur(cpt_carrier_off)	stop_timer(TVASB) init_timer(Tend)	Hide
W.TVASB1	time_out(TVASB)	FlagSendAlarm = TRUE init_timer(Tend)	Hide
W.TVASB1	time_out(Tend)	$none()	W.TVASB2
W.TVASB2	occur(cpt_carrier_off)	stop_timer(TVASB) station_signal(OFF)	Stopped
W.TVASB2	occur(data_carrier_on)	$none()	W.TVASB1
W.TVASB2	time_out(TVASB)	Send_AG(AGN)	W.AB
W.AB	AG_sent_event	FlagSendAlarm = FALSE station_signal(OFF)	Stopped

Tableau 6 – Transitions d'état de *Physical-62056-3-1*: Station secondaire

État initial	Condition de déclenchement	Ensemble d'actions	État final
Initial	energized()	MaxIndex=128 FlagRSO=FALSE FirstWinRSO=FALSE	Stopped
Initial	not(energized())	MaxIndex=18 FlagRSO=FALSE FirstWinRSO=TRUE	Stopped
Stopped	AG_received_event	Stop_timer(TOAG) init_timer(TA1O)	M.Rec
Stopped	Phy_ALARM.req()	TypeAG=ASB Send_AG(TypeAG)	W.ASB
Stopped	time_out(TOAG)	MaxIndex=18 FirstWinRSO=TRUE	Stopped
M.Rec	octet_received_event	Stop_timer(TA1O) Index=2 Frame="" Read_data(RecB) Concat(Frame, RecB) init_timer(TAO)	Receiving
M.Rec	time_out(TA1O)	Phy_ABORT(EP-1)	*WTOAG*
M.Rec	Phy_ABORT.req()	Stop_timer(TA1O)	*WTOAG*
Receiving	octet_received_event & Index<=MaxIndex	Stop_timer(TAO) Index=Index+1 Read_data(RecB) Concat(Frame, RecB) init_timer(TAO)	Receiving
Receiving	octet_received_event & Index>MaxIndex	Stop_timer(TAO) Phy_ABORT.ind(EP-4F)	*WTOAG*
Receiving	time_out(TAO)	Phy_DATA.ind(Frame) init_timer(TOL)	M.Send
Receiving	Phy_ABORT.req()	Stop_timer(TAO)	*WTOAG*
M.Send	Phy_DATA.req(Frame)	Stop_timer(TOL) MaxIndex=128 Size=size(Frame) Index=1 Send_octet(Frame, Index) Size=Size-1 init_timer(TOE)	Sending

État initial	Condition de déclenchement	Ensemble d'actions	État final
M.Send	Phy_RSO.req(Frame, Window)	Stop_timer(TOL) MaxIndex=128 Wait_window(FirstWinRSO, Window) FirstWinRSO=FALSE Size=size(Frame) Index=1 Send_octet(Frame, Index) Size=Size-1 FlagRSO=TRUE init_timer(TOE)	Sending
M.Send	time_out(TOL)	init_timer(TA1O)	M.Rec
M.Send	Phy_ABORT.req()	Stop_timer(TOL)	*WTOAG*
Sending	octet_sent_event & Size>0	Index=Index+1 Send_octet(Frame, Index) Size=Size-1	Sending
Sending	octet_sent_event & Size=0 & not(FlagRSO)	Stop_timer(TOE) init_timer(TA1O)	M.Rec
Sending	octet_sent_event & Size=0 & FlagRSO	Stop_timer(TOE) Wait_time(TAO) FlagRSO=FALSE	WTOAG
Sending	Phy_ABORT.req()	Stop_timer(TOE)	WTOAG
Sending	time_out(TOE)	Phy_ABORT.ind(EP-3F)	WTOAG
W.ASB	time_out(TOAG)	MaxIndex=18 FirstWinRSO=TRUE	W.ASB
W.ASB	AG_sent_event	$none()	Stopped
WTOAG	not(energized)	init_timer(TOAG)	Stopped
WTOAG	Energized	$none()	Stopped

Tableau 7 – Signification des états mentionnés dans les tableaux précédents

État	Signification
Initial	Initialisation des variables de la couche
Stopped	Attente d'un signal "Appel général"
W.ETABS (Wait for end of "Alarm-Bus")	Attente de la fin d'un signal "Alarme-Bus" reçu dans l'état Stopped
W.AG (Wait for end of "Wakeup Call")	Attente de la fin de l'émission d'un signal "Appel général"
W.TAB (Wait "Alarm-Bus")	Attente d'un signal "Alarme-Bus" pendant le retard en fin d'émission d'un signal "Appel général"
W.ETAB (Wait for end of "Alarm-Bus")	Attente de la fin d'un signal "Alarme-Bus" reçu après l'émission d'un signal "Appel général"
W.TASB	Attente du déclenchement du temps de réveil TASB après le début de la réception d'un signal "Alarme-Bus"
W.TOL	Attente du déclenchement du temps de réveil TOL
M.Send (Must Send)	État initial de l'émetteur, attente d'une trame à émettre
T.Session	Vérification du type de session (avec Station Secondaire alimentée ou téléalimentée)
SendFirst	Envoi du premier octet de la trame à émettre
Sending	État récurrent de l'émetteur, émission octet par octet
Answer	Branchement en fonction du service demandé
M.Rec (Must Receive)	État initial du récepteur, attente du premier octet d'une trame
Receiving	État récurrent du récepteur, réception octet par octet

État	Signification
Received	Traitement de la trame reçue en fonction du service demandé
T.RSO (Test last RSO)	Vérification de la fin du dernier intervalle de temps pour la réception d'une trame RSO
W.RSO (Wait for end of an RSO time slot)	Attente de la fin d'un intervalle de temps pour la réception d'une trame RSO
W.ASB	Attente de la fin d'émission d'un signal "Alarme Bus-Secondaire"
W.TOAG	Initialisation du temporisateur de fin de session TOAG si nécessaire
W.TOSEUIL	Attente du déclenchement du temps de réveil TOSEUIL
W.AGT	Attente d'un signal "Appel général" AGT
W.Sel (Wait for preSelection)	Attente d'une trame de présélection
Select	Réception d'une trame de présélection
W.Answer	Attente d'une trame de réponse en provenance d'une station sélectionnée
Hide	Attente de la fin d'une sélection
W.AGend	Attente de la fin de la réception d'un AG
W.TVASB1	Attente du déclenchement du temps de réveil TVASB pour un signal "Alarme Bus-Secondaire" durant une session
W.TVASB2	Attente du déclenchement du temps de réveil TVASB pour un signal "Alarme Bus-Secondaire" à la fin d'une session
W.AB	Attente de la fin d'émission d'un signal "Alarme-Bus"

Tableau 8 – Définition des procédures, des fonctions et des événements classés par ordre alphabétique

Procédure, fonction ou événement	Définition
AG_received_event	Événement issu du modem qui informe de la détection d'un signal "Appel général" AGN
AG_sent_event	Événement issu du modem qui informe de la fin de l'émission d'un signal "Appel général"
alarm_detection()	Vérification que la station a son mode alarme à Actif
collision_detected_event	Événement issu du modem qui informe de la détection d'une trame erronée sur réception d'un octet
concat(Frame, RecB)	Concaténation de l'octet RecB dans la trame Frame en cours de constitution
data_carrier_on, data_carrier_off	Occurrence de la détection de l'apparition ou de la disparition de la porteuse sur le bus
energized()	Vérification que la station est alimentée
init_timer(TOAPPEL), init_timer(TOSEUIL), init_timer(TAGT), init_timer(TOBAVARD), init_timer(TOPRE), init_timer(TOL), init_timer(TOE), init_timer(TAO), init_timer(TA1O), init_timer(TARSO) init_timer(TOAG), init_timer(TVASB) or init_timer(TAB)	Armement du temps de réveil TOAPPEL, TOSEUIL, TAGT, TOBAVARD, TOPRE, TOL, TOE, TAO, TA1O, TARSO, TOAG, TVASB ou TAB

Procédure, fonction ou événement	Définition
occur(cpt_carrier_on), occur(cpt_carrier_off), occur(data_carrier_on), occur(data_carrier_off), occur(octet_received_event) or occur(octet_sent_event)	Occurrence (signalisation sans consommation) de la détection de l'apparition ou de la disparition de la porteuse sur le bus secondaire, de la détection de l'apparition de la porteuse sur le bus, de la disparition de la porteuse, de la réception d'un octet ou de l'émission d'un octet
octet_received_event	Événement issu du modem qui informe qu'un octet a été reçu
octet_sent_event	Événement issu du modem qui informe qu'un octet a été émis
read_data(RecB)	Traitement de l'événement octet_received_event par lecture de l'octet RecB reçu (les bits sont transmis dans un ordre croissant)
send_AG(TypeAG)	Demande au modem d'effectuer l'émission d'un signal "Appel général" d'une durée TypeAG (AGN ou AGT)
send_octet(Frame, Index)	Émission de l'octet de rang Index dans la trame Frame (les bits sont transmis dans un ordre croissant)
size(Frame)	Calcul du nombre d'octets de la trame Frame
station_power(ON) or station_power(OFF)	Met en marche ou à l'arrêt l'alimentation en énergie du dispositif
station_signal(ON) or station_signal(OFF)	Met en marche ou à l'arrêt l'émission de signal vers le dispositif sur le bus secondaire
stop_timer(TOAPPEL), stop_timer(TOSEUIL), stop_timer(TAGT), stop_timer(TOBAVARD), stop_timer(TOPRE), stop_timer(TOL), stop_timer(TOE), stop_timer(TAO), stop_timer(TA1O), stop_timer(TVASB) or stop_timer(TAB)	Désarmement du temps de réveil TOAPPEL, TOSEUIL, TAGT, TOBAVARD, TOPRE, TOL, TOE, TAO, TA1O, TVASB ou TAB
stop_timer(TOAG) or stop_timer(TARSO)	Désarmement du temps de réveil TOAGT ou TARSO uniquement si elle a été préalablement armée
time_out(TOAPPEL), time_out(TOSEUIL), time_out(TAGT), time_out(TOBAVARD), time_out(TOPRE), time_out(TOL), time_out(TOE), time_out(TAO), time_out(TA1O), time_out(TARSO), time_out(TOAG), time_out(TVASB) or stop_timer(TAB)	Déclenchement du temps de réveil TOAPPEL, TOSEUIL, TAGT, TOBAVARD, TOPRE, TOL, TOE, TAO, TA1O, TARSO, TOAG, TVASB ou TAB
wait_time(TAO), wait_time(TICB), wait_time(TOL) or wait_time(TOALR)	Retard calculé pendant le temps TAO, TICB, TOL ou TOALR
wait_window(FirstWinRSO, Window)	Temps d'attente calculé de la façon suivante: FirstWinRSO=VRAI ou Window=0 ==> 0 ms FirstWinRSO=FAUX et Window>0 ==> 40 ms + (TARSO*Window) ms (Le retard de 40 ms permet de garantir que l'émission a bien lieu dans l'intervalle de temps prévu)

5.1.6 Liste et traitement des erreurs

Les erreurs sont répertoriées par les codes suivants:

EP = erreur dans la couche *Physique*

– = séparateur

N = numéro de l'erreur

F = erreur fatale

Les erreurs relatives à *Physical 62056-3-1* sont indiquées dans le Tableau 9.

Tableau 9 – Tableau récapitulatif des erreurs

EP-1	Délai du temps de réveil TOL (Station Primaire) écoulé avant que la couche *Liaison de données* n'ait demandé l'envoi d'une trame, ou temps de réveil TA10 (Station Secondaire) écoulé avant la réception d'un caractère en provenance de la Station Primaire
	Cette erreur conduit à l'attente d'un signal "Appel général" après avoir informé la couche *Liaison de données*
EP-2	Temps de réveil TOAG écoulé avant un signal "Appel général"
	Cette erreur conduit à l'attente d'un signal "Appel général" après avoir informé la couche *Liaison de données*
EP-3	Réception d'une alarme
	Cette erreur conduit à réinitialiser la couche *Physique* après avoir informé la couche *Liaison de données*
EP-3F	Durée anormale d'émission constatée après que le temps de réveil TOE est écoulé
	Cette erreur conduit à réinitialiser la couche *Physique* après avoir informé la couche *Liaison de données*
EP-4F	Nombre d'octets reçus supérieur à MaxIndex (Émetteur trop bavard)
	Cette erreur conduit à réinitialiser la couche *Physique* après avoir informé la couche *Liaison de données*
EP-5F	Temps de réveil TARSO écoulé en recevant une trame RSO (Station Primaire seulement)
	Cette erreur conduit à réinitialiser la couche *Physique* après avoir informé la couche *Liaison de données*

Toute occurrence de l'une de ces erreurs est remontée localement au moyen de la primitive de service Phy_ABORT.ind. La liste complète des numéros d'erreur fatale est fournie à l'Annexe C.

5.2 Couche Liaison de données

5.2.1 Protocole Link-62056-3-1

Le protocole *Link-62056-3-1* de la couche *Liaison de données* du profil d'échange de données par bus local sans DLMS adopte un comportement asymétrique. Le diagramme d'états de la Station Primaire est donc différent de celui de la Station Secondaire.

La couche *Liaison de données* est chargée de transformer le canal physique exploité par la couche *Physique* en canal logique apte à transmettre des informations fiables. Ses fonctions principales sont:

- effectuer une sérialisation et une désérialisation des données (dans la mesure où le canal physique fonctionne en série par bit);
- synchroniser les trames en émission et en réception;
- filtrer les trames en fonction des adresses primaire et secondaire;
- assurer une protection efficace contre les erreurs d'émission.

5.2.2 Gestion des échanges

Sur la Station Primaire, le protocole *Link-62056-3-1* prend en charge l'émission des signaux “Appel général” AGN ou AGT en fonction du type de la Station Secondaire. La détection d'une incompatibilité d'adresses dans un DSDU reçu de la couche supérieure entraîne une erreur fatale et l’arrêt du protocole *Link -62056-3-1.*

Sur la Station Secondaire, la réception d’une trame incorrecte ne donne lieu à aucun traitement, la récupération étant laissée à la charge de la Station Primaire.

Pour une station téléalimentée, la détection d’un “Appel des Stations Oubliées” après un signal “Appel général” AGT conduit à l’envoi d’une réponse RSO se situant toujours dans le premier intervalle de temps RSO. La Station Primaire, lorsqu’elle détecte une collision après une telle séquence, envoie un second “Appel des Stations Oubliées”, mais cette fois-ci après un signal “Appel général” AGN. Lorsqu’aucune collision n’est détectée après le premier appel, cela signifie qu’il n’y a au plus qu’une station oubliée, et il n’est pas nécessaire d’effectuer un deuxième appel.

5.2.3 Services et primitives de service de liaison de données

L'utilisateur du protocole *Link-62056-3-1* peut utiliser les services et primitives de service indiqués dans le Tableau 10.

Tableau 10 – Services et primitives de services de liaison de données

Service	Primitive de service
DL_DATA	DL_DATA.req(DSDU) DL_DATA.ind(DSDU)
DL_ALARM	DL_ALARM.req() DL_ALARM.ind()
DL_ABORT	DL_ABORT.req() DL_ABORT.ind(ErrorNb)

Le rôle attribué à chaque primitive est le suivant:

- DL_DATA.req(DSDU) permet à la couche *Application* de demander à la couche *Liaison de données* le transfert d'un paquet de données DSDU;
- DL_DATA.ind(DSDU) permet à la couche *Liaison de données* d'informer la couche *Application* de l'arrivée d'un paquet de données DSDU;
- DL_ALARM.req() permet à la couche *Application* de demander à la couche *Liaison de données* le transfert d’une alarme;
- DL_ALARM.ind() permet à la couche *Liaison de données* d'informer la couche *Application* de l'arrivée d’une alarme;
- DL_ABORT.req() permet à la couche *Application* de demander à la couche *Liaison de données* de mettre fin à son activité;
- DL_ABORT.ind(ErrorNb) permet à la couche *Liaison de données* d'informer la couche *Application* de l'occurrence d'une erreur fatale repérée par le numéro ErrorNb.

5.2.4 Paramètres de liaison de données

Pour une Station Primaire, la valeur du nombre MaxRetry de réémissions d'une même trame avant déconnexion est fixée à 2.

La valeur du nombre MaxChain de séquences enchaînées sans signal “Appel général” pour la télérelève et le télétransfert, est fixée à 5, de manière à assurer la compatibilité avec les Stations Secondaires utilisant une version antérieure du protocole.

La valeur du nombre maximal MaxRSO d'intervalles de temps RSO pour le traitement d'un "Appel des Stations Oubliées" est fixée à 3 après un "Appel général" AGN, et à 1 après un "Appel général" AGT.

La Station Secondaire doit connaître la liste des adresses de Stations Primaires et la liste des TABi auxquels elle a été sensibilisée.

Une station peut également être sollicitée par l'intermédiaire d'une adresse primaire générale APG. Dans ce cas, elle répond avec la première adresse primaire de la liste à laquelle elle a été sensibilisée.

5.2.5 Transitions d'état

Les transitions d'état de *Link-62056-3-1* sont indiquées dans le Tableau 11, le Tableau 12, le Tableau 13 et le Tableau 14.

Tableau 11 – Transitions d'état de *Link-62056-3-1*: Station Primaire

État initial	Condition de déclenchement	Ensemble d'actions	État final
Initial	$true()	MaxRetry=2 MaxChain=5	Stopped
Stopped	DL_DATA.req(DSDU) & check_req(DSDU)	NbChain=0 MaxRSO=3 PreSel=FALSE NoRetry=FALSE RepeatASO=FALSE EP-1=FALSE context(ADS, ADP, TypeAG) Com=command(DSDU) init(Com, TypeAG) Phy_APPG.req(TypeAG)	W.AG
Stopped	DL_DATA.req(DSDU) & not(check_req(DSDU))	DL_ABORT.ind(EL-1F)	Stopped
Stopped	Phy_ALARM.ind()	DL_ALARM.ind()	Stopped
W.AG	Phy_APPG.ind() & not(PreSel) & not(NoRetry) & not(RepeatASO)	$none()	*T.Req*
W.AG	Phy_APPG.ind() & PreSel	Index=MaxRetry+1 Fr=PRE Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
W.AG	Phy_APPG.ind() & NoRetry	Index=MaxRetry+1 Fr=DSDU Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) NbChain=1 Phy_DATA.req(Fr) NoRetry=FALSE	M.Rec
W.AG	Phy_APPG.ind() & RepeatASO	RepeatASO=FALSE Phy_ASO.req(Fr)	M.RSO
W.AG	DL_ABORT.req()	Phy_ABORT.req()	W.EndS
W.EndS	Phy_ABORT.ind(ErrorNb)	$none()	*T.Error*
W.EndS	Phy_ALARM.ind()	DL_ALARM.ind()	Stopped
T.Error	((Error_Nb = EP-1 & TypeAG = AGN) I (Error_Nb = EP-2 & TypeAG = AGT)) & Com <>IB & Com <> TRB	$none()	Stopped

État initial	Condition de déclenchement	Ensemble d'actions	État final
T.Error	((Error_Nb = EP-1 & TypeAG = AGN) I (Error_Nb = EP-2 & TypeAG = AGT)) & (Com=IB | Com=TRB)	DL_ABORT.ind(Error_Nb)	Stopped
T.Error	Error_Nb <> EP-1 & Error_Nb <> EP-2	DL_ABORT.ind(Error_Nb)	W.EndS
T.Error	(Error_Nb = EP-1) & TypeAG = AGT	$none()	W.EndS
T.Req	Com=IB | Com=TRB	Fr=DSDU Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_UNACK.req(Fr)	W.EndS
T.Req	Com=ASO & TypeAG=AGN	MaxRSO=3 NbRSO=1 ListRSO="" Collision=FALSE Fr=DSDU Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_ASO.req(Fr)	M.RSO
T.Req	Com=ASO & TypeAG=AGT	MaxRSO=1 NbRSO=1 ListRSO="" Collision=FALSE Fr=DSDU Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_ASO.req(Fr)	M.RSO
T.Req	((NbChain<MaxChain) & (Com=ENQ | Com=TRF)) | (NbChain=0 & Com=REC)	Fr=DSDU Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Index=1 NbChain=NbChain+1 Phy_DATA.req(Fr)	M.Rec
T.Req	Com=AUT	Fr=DSDU Fr=concat(size_frame(Fr),ADS,ADP,Fr) Fr=concat(Fr, crc(Fr)) Index=1 NbChain=MaxChain Phy_DATA.req(Fr)	M.Rec
T.Req	(NbChain>=MaxChain) | (NbChain<>0 & Com=REC)	NbChain=0 Phy_APPG.req(AGN)	W.AG
M.Rec	Phy_DATA.ind(Frame) & check_frame(Frame) & not(PreSel)	DSDU=extract_DSDU(Frame) DL_DATA.ind(DSDU)	M.Send
M.Rec	Phy_DATA.ind(Frame) & check_frame(Frame) & command(Frame)=SEL & PreSel	PreSel=FALSE	*T.Req*
M.Rec	Phy_DATA.ind(Frame) & check_frame(Frame) & command(Frame)<>SEL & PreSel	Phy_ABORT.req() DL_ABORT.ind(EL-2F)	W.EndS
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame)) & Index<=MaxRetry	Index=Index+1 Phy_DATA.req(Fr)	M.Rec
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame)) & Index>MaxRetry	Phy_ABORT.req() DL_ABORT.ind(EL-2F)	W.EndS
M.Rec	DL_ABORT.req()	Phy_ABORT.req()	W.EndS
M.Rec	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	W.EndS
M.RSO	Phy_ASO.ind(Frame) & size(Frame)=0	$none()	*T.RSO*

État initial	Condition de déclenchement	Ensemble d'actions	État final
M.RSO	Phy_ASO.ind(Frame) & size(Frame)<>0 & check_frame(Frame) & command(Frame)=RSO	build_RSO(ListRSO, Frame)	*T.RSO*
M.RSO	Phy_ASO.ind(Frame) & size(Frame)<>0 & not(check_frame(Frame))	Collision=TRUE	*T.RSO*
M.RSO	Phy_COLL.ind()	Collision=TRUE	*T.RSO*
M.RSO	DL_ABORT.req()	Phy_ABORT.req()	W.EndS
M.RSO	Phy_ABORT.int(ErrorNb)	DL_ABORT.ind(ErrorNb)	W.EndS
T.RSO	MaxRSO=1 & Collision	MaxRSO=3 Collision=FALSE RepeatASO=TRUE Phy_APPG.req(AGN)	W.AG
T.RSO	(MaxRSO=1 & not(Collision)) | (MaxRSO<>1 & NbRSO>=MaxRSO)	DSDU=rso(RSO, Collision, ListRSO) DL_DATA.ind(DSDU)	W.EndS
T.RSO	NbRSO<MaxRSO	NbRSO=NbRSO+1	M.RSO
M.Send	DL_DATA.req(DSDU) & check_req(DSDU) & not(EP-1)	Com=command(DSDU)	*T.Req*
M.Send	DL_DATA.req(DSDU) & check_req(DSDU) & EP-1	Com=command(DSDU) NbChain=0 EP-1=FALSE Phy_APPG.req(AGN)	W.AG
M.Send	DL_DATA.req(DSDU) & not(check_req(DSDU))	Phy_ABORT.req() DL_ABORT.ind(EL-1F)	W.EndS
M.Send	Phy_ABORT.ind(EP-1)	EP-1=TRUE	M.Send
M.Send	Phy_ABORT.ind(EP-2)	$none()	Stopped
M.Send	DL_ABORT.req() & not(EP_1 & TypAG=AGN)	Phy_ABORT.req()	W.EndS
M.Send	DL_ABORT.req() & EP_1 & TypAG=AGN	$none()	Stopped
M.Send	Phy_ABORT.ind(ErrorNb) & ErrorNb<>EP-1 & ErrorNb<>EP-2	DL_ABORT.ind(ErrorNb)	W.EndS

Tableau 12 – Transitions d'état de *Link-62056-3-1*: Station secondaire

État initial	Condition de déclenchement	Ensemble d'actions	État final
Initial	$true()	FlagDSO=TRUE Discovered=FALSE Flag_alarm = FALSE	Stopped
Stopped	Phy_DATA.ind(Frame) & check_frame(Frame) & check_address(Frame)	ADP=extract_ADP(Frame) Com=command(Frame)	*T.Com*
Stopped	Phy_DATA.ind(Frame) & check_frame(Frame) & not(check_address(Frame))	Phy_ABORT.req()	Stopped
Stopped	Phy_DATA.ind(Frame) & not(check_frame(Frame))	$none()	Stopped
Stopped	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	Stopped
Stopped	DL_ALARM.req()	Phy_ALARM.req() Flag_alarm = TRUE	Stopped
T.Com	Com=IB	FlagDSO=TRUE Discovered=FALSE Phy_ABORT.req()	Stopped
T.Com	Com=TRB	DSDU=extract_DSDU(Frame) DL_DATA.ind(DSDU) Phy_ABORT.req()	Stopped
T.Com	Com=PRE	Fr=SEL Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	Stopped
T.Com	Com=ASO & test_TABi(Frame, TAB)	Fr=concat(RSO, TAB, ADS) Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_RSO.req(Fr, window_RSO())	Stopped
T.Com	Com=ASO & not(test_TABi(Frame, TAB))	Phy_ABORT.req()	Stopped
T.Com	Com=ENQ | Com=REC | Com=TRF | COM=AUT	DSDU=extract_DSDU(Frame) DL_DATA.ind(DSDU)	M.Send
M.Send	DL_DATA.req(DSDU)	Fr=DSDU Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) update_flag_DSO(command(Fr))	Stopped
M.Send	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	Stopped

Tableau 13 – Signification des états mentionnés dans les tableaux précédents

État	Signification
Initial	Initialisation des variables de la couche
Stopped	Attente de la première demande de la couche supérieure ou de la première indication de la couche inférieure
W.AG (Wait for end of “Wakeup Call”)	Attente de la fin d’un signal “Appel général” demandé
W.EndS (Wait for End of Session)	Attente de la fin d’une session
T.Req (Test Request)	Essai de la nature d’une demande en provenance d’une couche supérieure
M.Rec (Must Receive)	Attente d’une réponse en provenance de la couche inférieure
M.RSO (Must receive RSO)	Attente d’une trame RSO après l’envoi d’une trame ASO
T.RSO (Test last RSO)	Vérification de la fin du dernier intervalle de temps pour la réception d’une trame RSO
M.Send (Must Send)	Attente d’une requête de la couche supérieure
T.Com (Test Command)	Essai du code de commande d’une trame reçue

Tableau 14 – Définition des procédures et des fonctions classées par ordre alphabétique

Procédure ou fonction	Définition
build_RSO(ListRSO, Frame)	Extraction des éléments (champs TAB et ADS) de la trame RSO reçue Frame et concaténation avec la précédente liste ListRSO
check_address(Frame)	Vérification que les adresses ADP et ADS sont reconnues selon les critères suivants: – la station est sensibilisée à l'ADP ou ADP=APG; – ADS=ADG si le code de commande est ASO, IB ou TRB, – ADS est l’adresse de la station secondaire si le code de commande n'est pas ASO, IB ou TRB
check_frame(Frame)	Vérification que la trame Frame reçue est correcte: – nombre d'octets supérieur ou égal à 11 et inférieur ou égal à 128; – CRC correct; – nombre d’octets compatible avec le champ N – code de commande connu et nombre d’octets compatible avec ce code de commande
check_req(DSDU)	Vérification que le code de commande demandé du DSDU est compatible avec les adresses ADP et ADS du contexte de communication
command(DSDU) or command(Frame)	Extraction de la valeur du code de commande dans le DSDU à envoyer ou de la trame Frame reçue
concat(N, ADS, ADP, DSDU) or concat(Frame, CRC)	Concaténation des champs N, ADS, ADP et du DSDU ou concaténation du CRC à la fin de la trame Frame
context(ADS, ADP, TypeAG)	Extraction des valeurs correspondantes du contexte de communication
crc(Frame)	Calcul du CRC de la trame Frame à émettre
extract_ADP(Frame)	Si la valeur de l’ADP utilisée dans la trame est différente de APG ou bien s’il s’agit de APG mais que la liste des valeurs ADP auxquelles est sensibilisée la Station Secondaire est vide, extraction de cette valeur, sinon extraction de la première valeur ADP à laquelle est sensibilisée la Station Secondaire

Procédure ou fonction	Définition
extract_DSDU(Frame)	Extraction du DSDU (champs COM et DATA) de la trame Frame reçue
init(COM, TypeAG)	Met PreSel à VRAI si à la fois TypeAG est égal à AGT et la taille de la trame est supérieure à 18 octets. Met NoRetry à VRAI si à la fois TypeAG est égal à AGT et la taille de la trame est inférieure ou égale à 18 octets.
rso(RSO, Collision, ListRSO)	Concaténation du code de commande RSO, de l'indicateur de collision et de la liste d'éléments RSO (champs TAB et ADS)
size(Frame)	Calcul de la taille de la trame Frame reçue
size_frame(DSDU)	Calcul de la taille de la trame associée à un DSDU à émettre (taille du DSDU + 10)
test_TABi(Frame, TAB)	Si le premier TABi contenu dans la trame ASO Frame reçue vaut 00, vérification que la variable Discovered est à FAUX et vérification, après tirage d'un nombre aléatoire entre 0 et 100, que ce nombre entier est inférieur à la probabilité de réponse souhaitée au deuxième des TABi. Dans ce cas, la valeur 00 est mémorisée dans la variable TAB; Si le premier TABi contenu dans la trame ASO Frame reçue vaut FF, vérification que la variable Flag_alarm est à VRAI et dans ce cas, affectation de la valeur FAUX à la variable Flag_alarm et mémorisation de la valeur FF dans la variable TAB; Si le premier TABi contenu dans la trame ASO Frame reçue ne vaut ni 00 ni FF, vérification que la variable FlagDSO est à VRAI, que la Station Secondaire est sensibilisée à l'un des TABi contenus dans la trame Frame ASO reçue. Dans ce cas, mémorisation de la première de ces valeurs dans la variable TAB
update_flag_DSO(COM)	Affectation de la valeur FAUX à la variable FlagDSO et de la valeur VRAI à la variable Discovered si COM est la commande ENQ
window_RSO()	Fourniture d'une valeur aléatoire entière comprise entre 0 et MaxRSO-1 utilisée comme numéro de l'intervalle de temps RSO au cours duquel la station doit répondre (voir l'Annexe F)

5.2.6 Liste et traitement des erreurs

Les erreurs sont répertoriées par les codes suivants:

EL = erreur de la couche *Liaison de données*

– = séparateur

N = numéro de l'erreur

F = erreur fatale

Les erreurs relatives à *Link-62056-3-1* sont indiquées dans le Tableau 15.

Tableau 15 – Tableau récapitulatif des erreurs

EL-1F	Réception d'un code de commande incompatible avec les adresses ADP et ADS mémorisées dans le contexte de communication (Station Primaire seulement)
	Cette erreur conduit à réinitialiser la couche *Liaison de données* après avoir informé la couche *Application*
EL-2F	Réponse incorrecte de la Station Secondaire après, soit une trame de présélection pour une station téléalimentée, soit MaxRetry répétitions d'une requête (Station Primaire seulement)
	Cette erreur conduit à réinitialiser la couche *Liaison de données* après avoir informé la couche *Application*

Toute occurrence de l'une de ces erreurs est remontée localement au moyen de la primitive de service DL_ABORT.ind. La liste complète des numéros d'erreur fatale est fournie à l'Annexe C.

5.3 Couche Application

5.3.1 Protocole Application-62056-3-1

Le protocole *Application-62056-3-1* de la couche *Application* du profil d'échange de données par bus local sans DLMS adopte un comportement asymétrique. Le diagramme d'états de la Station Primaire est donc différent de celui de la Station Secondaire.

Le protocole *Application-62056-3-1* de la couche *Application* du profil d'échange de données par bus local sans DLMS est chargé de contrôler et d'enchaîner les messages successifs par analyse d'un code de commande fourni par l'application utilisatrice.

5.3.2 Services et primitives de service d'Application

L'utilisateur du protocole *Application-62056-3-1* peut utiliser les services et primitives de service indiqués dans le Tableau 16.

Tableau 16 – Services et primitives de services d'Application

Service	Primitive de service
A_DATA	A_DATA.req(COM, ASDU) A_DATA.ind(ASDU)
A_ALARM	A_ALARM.req() A_ALARM.ind()
A_ABORT	A_ABORT.req() A_ABORT.ind(ErrorNb)

Le rôle attribué à chaque primitive est le suivant:

- A_DATA.req(COM, ASDU) permet à l'application de demander à la couche *Application* le transfert d'une commande COM (ENQ, REC, TRF, TRB, IB ou ASO pour une Station Primaire et DAT, DRJ, EOS ou TRA pour une Station Secondaire) associée à un ASDU;
- A_DATA.ind(ASDU) permet à la couche *Application* d'informer l'application de l'arrivée d'un ASDU;
- A_ALARM.req() permet à l'application de demander à la couche *Application* l'envoi d'une alarme;
- A_ALARM.ind() permet à la couche *Application* d'informer l'application de l'arrivée d'une alarme;
- A_ABORT.req() permet à l'application de demander à la couche *Application* de mettre fin à son activité;
- A_ABORT.ind(ErrorNb) permet à la couche *Application* d'informer l'application de l'occurrence d'une erreur fatale repérée par le numéro ErrorNb.

5.3.3 Paramètres d'Application

La Station Primaire doit posséder les clefs de cryptage DES associées à chacune des Stations Secondaires sur lesquelles une téléprogrammation doit être réalisée.

Dans le cas d'une téléprogrammation, la Station Secondaire doit posséder la clef de cryptage DES utilisée par la Station Primaire.

5.3.4 Transitions d'état

Les transitions d'état d'*Application-62056-3-1* sont indiquées dans le Tableau 17, le Tableau 18, le Tableau 19 et le Tableau 20.

Tableau 17 – Transitions d'état d'*Application-62056-3-1*: Station Primaire

État initial	Condition de déclenchement	Ensemble d'actions	État final
Stopped	A_DATA.req(Com, ASDU) & (Com=ASO | Com=ENQ | Com=TRF)	APDU=concat(Com, _, _, ASDU) DL_DATA.req(APDU)	M.Rec
Stopped	A_DATA.req(Com, ASDU) & (Com=IB | Com=TRB)	APDU=concat(Com, _, _, ASDU) DL_DATA.req(APDU)	W.EndS
Stopped	A_DATA.req(Com, ASDU) & Com=REC	Na1=randomize() Zdt=zdt(ASDU) APDU=concat(REC, Na1, 0, Zdt) DL_DATA.req(APDU) Na1k=cipher(Na1)	M.Rec
Stopped	DL_ALARM.ind()	A_ALARM.ind()	Stopped
Stopped	A_ABORT.req()	DL_ABORT.req()	Stopped
M.Rec	DL_DATA.ind(DSDU)	Resp=command(DSDU)	*T.Resp*
M.Rec	A_ABORT.req()	DL_ABORT.req()	Stopped
M.Rec	DL_ABORT.ind(ErrorNb) & Error_Nb <> EP_1 & Error_Nb <> EP_2	A_ABORT.ind(ErrorNb)	Stopped
M.Rec	DL_ABORT.ind(ErrorNb) & (Error_Nb = EP_1 I Error_Nb = EP_2)	$none()	M.Rec
W.EndS	DL_ABORT.ind(ErrorNb)	A_ABORT.ind(ErrorNb)	Stopped
W.EndS	A_ABORT.req()	DL_ABORT.req()	W.EndS
T.Resp	(Com=ASO & Resp=RSO) | (Com=ENQ & Resp=DAT) | (Com=ENQ & Resp=DRJ) | (Com=TRF & Resp=TRA) | (Com=TRF & Resp=DRJ) | (Com=AUT & Resp=EOS) | (Com=AUT & Resp=DRJ)	A_DATA.ind(DSDU)	Stopped
T.Resp	Com=REC & Resp=ECH & na1k(DSDU)=Na1k & Zdt=zdt(DSDU)	Na2=na2(DSDU) Na2k=cipher(Na2) Com=AUT APDU=concat(AUT, 0, Na2k, '''') DL_DATA.req(APDU)	M.Rec
T.Resp	(Com=ASO & Resp<>RSO) | (Com=ENQ & Resp<>DAT & Resp<>DRJ) | (Com=TRF & Resp<>TRA & Resp<>DRJ) | (Com=REC & Resp<>ECH) | (Com=AUT & Resp<>ARJ & Resp<>DRJ & Resp<>EOS)	A_ABORT.ind(EA-1F) DL_ABORT.req()	Stopped
T.Resp	Com=REC & (Resp<>ECH | (na1k(DSDU)<>Na1k) | (Zdt<>zdt(DSDU))	A_ABORT.ind(EA-2F) DL_ABORT.req()	Stopped
T.Resp	Com=AUT & Resp=ARJ	A_ABORT.ind(EA-3F) DL_ABORT.req()	Stopped

Tableau 18 – Transitions d'état d'*Application-62056-3-1*: Station secondaire

État initial	Condition de déclenchement	Ensemble d'actions	État final
Stopped	DL_DATA.ind(DSDU) & (command(DSDU)=ENQ | command(DSDU)=TRF)	A_DATA.ind(DSDU) Req=command(DSDU)	M.Send
Stopped	DL_DATA.ind(DSDU) & command(DSDU)=TRB	A_DATA.ind(DSDU)	Stopped
Stopped	DL_DATA.ind(DSDU) & command(DSDU)=REC	Zdt=zdt(DSDU) Na1=na1(DSDU) Na1k=cipher(Na1) Na2=randomize() APDU=concat(ECH, Na1k, Na2, Zdt) DL_DATA.req(APDU) Na2k=cipher(Na2) Req=REC	W.AUT
Stopped	A_ALARM.req() & alarm_detection()	DL_ALARM.req()	Stopped
M.Send	A_DATA.req(COM, ASDU) & (((COM=DAT | COM=DRJ) & Req=ENQ) | ((COM=TRA | COM=DRJ) & Req=TRF) | (COM=DRJ & Req=REC))	APDU=concat(COM, _, _, ASDU) DL_DATA.req(APDU)	Stopped
M.Send	A_DATA.req(COM, ASDU) & (COM=EOS & Req=REC)	APDU=concat(EOS, 0, 0, ‘’’’) DL_DATA.req(APDU)	Stopped
M.Send	DL_ABORT.ind(ErrorNb)	A_ABORT.ind(ErrorNb)	Stopped
W.AUT	DL_DATA.ind(DSDU) & command(DSDU)=AUT & na2k(DSDU)=Na2k	ASDU=concat(REC, _, _, Zdt) A_DATA.ind(ASDU)	M.Send
W.AUT	DL_DATA.ind(DSDU) & command(DSDU)=AUT & na2k(DSDU)<>Na2k	APDU=concat(ARJ, _, _, ‘’’’) DL_DATA.req(APDU)	Stopped
W.AUT	DL_ABORT.ind(ErrorNb)	A_ABORT.ind(ErrorNb)	Stopped

Tableau 19 – Signification des états mentionnés dans les tableaux précédents

État	Signification
Stopped	Attente de la première demande de la couche supérieure ou de la première indication de la couche inférieure
M.Rec (Must Receive)	Attente de la réponse à la requête émise
T.Resp (Test Response)	Traitement de la réponse reçue
M.Send (Must Send)	Attente d'une réponse à une requête reçue
W.AUT (Wait for AUT frame)	Attente de la trame AUT consécutive à une réponse ECH envoyée

Tableau 20 – Définition des procédures et des fonctions classées par ordre alphabétique

Procédure ou fonction	Définition
alarm_detection()	Vérification que le mode Alarme est Actif
cipher(Na1) or cipher(Na2)	Cryptage du nombre aléatoire Na1 ou Na2 N par l'algorithme DES avec la clef du contexte de communication
command(DSDU)	Extraction du code de commande d'un DSDU reçu
concat(COM, _, _, ASDU), concat(COM, ZA1, ZA2, ZDT) or concat(COM, 0, 0, _)	Concaténation d'un code de commande COM et d'un ASDU ou concaténation d'un code de commande COM, d'une valeur cryptée ZA1, d'une valeur cryptée ZA2 et d'un champ de données ZDT (champs TAB et DATA) ou concaténation d'un code de commande COM et des champs ZA1 = 0 et ZA2 = 0
na1(DSDU)	Extraction de la valeur Na1 du champ ZA1 d'une trame REC reçue
na1k(DSDU)	Extraction de la valeur Na1k du champ ZA1 d'une trame ECH reçue
na2(DSDU)	Extraction de la valeur Na2 du champ ZA2 d'une trame ECH reçue
na2k(DSDU)	Extraction de la valeur Na2k du champ ZA2 d'une trame AUT reçue
randomize()	Génération d'un nombre aléatoire suivant la procédure définie à l'Annexe G
zdt(ASDU) or zdt(DSDU)	Extraction de données (champs TAB et DATA) d'une demande de type REC, d'une trame REC ou d'une trame ECH

5.3.5 Liste et traitement des erreurs

Les erreurs sont répertoriées par les codes suivants:

EP = erreur de la couche *Application*

– = séparateur

N = numéro de l'erreur

F = erreur fatale

Les erreurs relatives à *Link-62056-3-1* sont indiquées dans le Tableau 21.

Tableau 21 – Tableau récapitulatif des erreurs

EA-1F	Le code de commande de la réponse de la trame reçue ne correspond pas au code de commande de la requête (Station Primaire seulement)
	Cette erreur conduit à réinitialiser la couche *Application* après avoir informé l'application
EA-2F	Erreur d'authentification de la Station Secondaire (Station Primaire seulement)
	Cette erreur conduit à réinitialiser la couche *Application* après avoir informé l'application
EA-3F	Erreur d'authentification de la Station Primaire (Station Primaire seulement)
	Cette erreur conduit à réinitialiser la couche *Application* après avoir informé l'application

Toute occurrence de l'une de ces erreurs est remontée localement au moyen de la primitive de service A_ABORT.ind. La liste complète des numéros d'erreur fatale est fournie à l'Annexe C.

6 Échange de données par bus local avec DLMS

6.1 Couche Physique

Le protocole *Physical-62056-3-1* de la couche *Physique* du profil d'échange de données par bus local avec DLMS est exactement le même que celui défini pour le profil sans DLMS.

6.2 Couche Liaison de données

6.2.1 Protocole Link-E/D

Le protocole *Link-E/D* de la couche *Liaison de données* du profil d'échange de données par bus local avec DLMS adopte un comportement asymétrique. Le diagramme d'états de la Station Primaire est donc différent de celui de la Station Secondaire.

La couche *Liaison de données* est chargée de transformer le canal physique exploité par la couche *Physique* en canal logique apte à transmettre des informations fiables. Ses fonctions principales sont:

- gérer directement les services d'Initialisation de Bus et d'Appel des Stations Oubliées;
- effectuer la sérialisation et la désérialisation des données (dans la mesure où le canal physique fonctionne en série par bit);
- synchroniser les trames en émission et en réception;
- filtrer les trames en fonction des adresses primaire et secondaire;
- assurer une protection efficace contre les erreurs de transmission.

6.2.2 Gestion des échanges

Les services d'Initialisation de Bus, Alarme et Appel des Stations Oubliées sont assurés par le protocole *Link-E/D* de la couche *Liaison de données* du profil d'échanges de données par bus local avec DLMS, mais les opérations sont réalisées en dehors de la couche *Application*. En particulier, le fanion de station oubliée peut être mis à jour par l'interface de programmation de l'application alors qu'une télérelève a lieu.

Sauf pour l'ouverture d'une session de communication, durant l'Initialisation de Bus, la signalisation d'Alarme et la gestion de l'Appel des Stations Oubliées, le protocole est complètement symétrique, et les deux stations sont à tour de rôle Émetteur et Récepteur.

Après l'envoi d'une trame, la couche *Liaison de données* du côté Emetteur attend toujours une trame de la couche *Liaison de données* du Récepteur avant d'émettre à nouveau. Cette attente est contrôlée par le temps de réveil T1, d'une durée de 10 s.

Après l'envoi d'une trame et la réception de l'acquittement de l'envoi précédent, la trame courante est retransmise. Le nombre de réémissions est limité à MaxRetry. Au-delà de ce nombre, la communication est interrompue au niveau *Liaison de données* et la couche *Application* en est informée.

A chaque réception de trame par l'un des systèmes, il y a émission immédiate d'une trame en réponse. Cette trame peut contenir des données de la couche *Application*. Elle contient toujours un numéro dans le champ *Send* et un numéro dans le champ *Confirm*, calculés en fonction des valeurs précédemment envoyées et reçues. L'algorithme de calcul de ces numéros est le suivant:

- si la dernière trame reçue est sans erreur et que son numéro *Send* est égal au complément à 1 du numéro *Confirm* précédent en émission, alors le paquet de données est transmis à la couche *Application* et la prochaine trame envoyée aura un numéro *Confirm* égal au numéro *Send* reçu. Sinon le numéro *Confirm* reste inchangé et le paquet de données n'est pas transmis à la couche *Application*;
- si la dernière trame reçue est sans erreur et que son numéro *Confirm* est identique au numéro *Send* précédent en émission, alors le numéro *Send* en émission est complété à 1 pour la prochaine trame dans l'hypothèse qu'un nouveau paquet de données doit être envoyé;
- si la dernière trame reçue est incorrecte ou si son numéro *Confirm* n'est pas identique au numéro *Send* précédent en émission, alors la même trame est de nouveau transmise sous réserve que le nombre de réémissions reste inférieur ou égal à MaxRetry.

6.2.3 Services et primitives de service de liaison de données

L'utilisateur du protocole *Link-E/D* peut utiliser les services et primitives de service indiqués dans le Tableau 22.

Tableau 22 – Services et primitives de services de liaison de données

Service	Primitive de service
DL_DATA	DL_DATA.req(Pr, DSDU) DL_DATA.ind(Pr, DSDU)
DL_IB	DL_IB.req()
DL_ASO	DL_ASO.req(DSDU) DL_ASO.ind(Collision, List)
DL_ALARM	DL_ALARM.req()
DL_ABORT	DL_ABORT.req(Strong) DL_ABORT.ind(ErrorNb)

Le rôle attribué à chaque primitive est le suivant:

- DL_DATA.req(Pr, DSDU) permet à la couche *Application* de demander à la couche *Liaison de données* le transfert d'un paquet de données DSDU avec la priorité Pr [3];
- DL_DATA.ind(Pr, DSDU) permet à la couche *Liaison de données* d'informer la couche *Application* de l'arrivée d'un paquet de données DSDU avec la priorité Pr;
- DL_IB.req() permet à la Gestion du support de demander à la couche *Liaison de données* l'envoi d'une trame Initialisation du Bus;
- DL_ASO.req(DSDU) permet à la Gestion du support de demander à la couche *Liaison de données* l'envoi d'une trame Appel des Stations Oubliées en cohérence avec un paquet de données DSDU;
- DL_ASO.ind(Collision, List) permet à la couche *Liaison de données* d'informer l'*interface de programmation de l'Application* du résultat d'un Appel des Stations Oubliées;
- DL_ALARM.req() permet à la Gestion du support de demander à la couche *Liaison de données* l'envoi d'une alarme;
- DL_ABORT.req(Strong) permet à la couche *Application* de demander à la couche *Liaison de données* de mettre fin à son activité avec la priorité Strong [4];
- DL_ABORT.ind(ErrorNb) permet à la couche *Liaison de données* d'informer la couche *Application* de l'occurrence d'une erreur fatale repérée par le numéro ErrorNb.

6.2.4 Paramètres de liaison de données

La valeur du nombre MaxRetry de réémissions d'une même trame avant déconnexion est fixée à 2.

Pour une Station Primaire, la valeur du nombre maximal MaxRSO d'intervalles de temps RSO pour le traitement d'un "Appel des Stations Oubliées" est fixée à 3.

La Station Secondaire doit connaître la liste des adresses de Stations Primaires et la liste des TABi auxquels elle a été sensibilisée.

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[3] Le paramètre de priorité Pr différencie le traitement d'un service urgent tel que InformationReport (niveau Pr=1) d'un autre service DLMS (niveau Pr=0).

[4] Le paramètre de priorité Strong différencie le traitement des erreurs fatales (Strong=1) de celui d'une autre demande de déconnexion physique (Strong=0) initialisée par la sous-couche *Application*.

Une station peut également être sollicitée par l'intermédiaire d'une adresse primaire générale APG. Dans ce cas, elle répond avec la première adresse primaire à laquelle elle a été sensibilisée.

6.2.5 Transitions d'état

Les transitions d'état de *Link-E/D* sont indiquées dans le Tableau 23, le Tableau 24, le Tableau 25 et le Tableau 26.

Tableau 23 – Transitions d'état de *Link-E/D:* Station Primaire

État initial	Condition de déclenchement	Ensemble d'actions	État final
Initial	$true()	MaxRetry=2 MaxChain = 5 init_incrChain()	Stopped
Stopped	exist_dl_req()	NbChain = 0 RepeatASO=FALSE context(ADP, ADS, TypeAG) init(TypeAG) Phy_APPG.req(TypeAG)	W.AG
Stopped	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	Stopped
Stopped	Phy_ALARM.ind()	create_alarm(TPDU) DL_DATA.ind(Pr = 1, TPDU)	Stopped
W.AG	Phy_APPG.ind() & not(RepeatASO) & NbChain = 0	$none()	*T.Req*
W.AG	Phy_APPG.ind() & not(RepeatASO) & NbChain <> 0	NbChain = 0	*M.Send*
W.AG	Phy_APPG.ind() & RepeatASO	RepeatASO=FALSE Phy_ASO.req(Fr)	M.RSO
W.AG	DL_ABORT.req(_)	Phy_ABORT.req()	W.EndS
W.EndS	(Phy_ABORT.ind(EP-2) & TypeAG=AGT) I (Phy_ABORT.ind(EP-1) & TypeAG=AGN)	$none()	Stopped
W.EndS	Phy_ALARM.ind	create_alarm(TPDU) DL_DATA.ind(Pr = 1, TPDU)	Stopped
W.EndS	Phy_ABORT.ind(ErrorNb) & ErrorNb<>EP-1 & ErrorNb<>EP-2	DL_ABORT.ind(ErrorNb)	W.EndS
T.Req	exist_dl_req(DL_IB.req())	Fr=“” Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, IB, Fr) Fr=concat(Fr, crc(Fr)) Phy_UNACK.req(Fr)	W.EndS
T.Req	exist_dl_req(DL_ASO.req(DSDU)) & TypeAG=AGN	MaxRSO=3 NbRSO=1 ListRSO=“” Collision=FALSE Fr=DSDU Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, ASO, Fr) Fr=concat(Fr, crc(Fr)) Phy_ASO.req(Fr)	M.RSO
T.Req	exist_dl_req(DL_ASO.req(DSDU)) & TypeAG=AGT	MaxRSO=1 NbRSO=1 ListRSO="" Collision=FALSE Fr=DSDU Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, ASO, Fr) Fr=concat(Fr, crc(Fr)) Phy_ASO.req(Fr)	M.RSO

État initial	Condition de déclenchement	Ensemble d'actions	État final
T.Req	not (exist_dl_req(DL_IB.req()) | exist_dl_req(DL_ASO.req(_)))	Pr=0 Send="00"B Confirm="11"B Fr="" Index=Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.RSO	Phy_ASO.ind(Frame) & size(Frame)=0	$none()	*T.RSO*
M.RSO	Phy_ASO.ind(Frame) & check_frame(Frame) & command(Frame)=RSO	build_RSO(ListRSO, Frame)	*T.RSO*
M.RSO	Phy_ASO.ind(Frame) & not(check_frame(Frame)) & size(Frame)<>0	Collision=TRUE	*T.RSO*
M.RSO	Phy_COLL.ind()	Collision=TRUE	*T.RSO*
M.RSO	DL_ABORT.req(_)	Phy_ABORT.req()	W.EndS
M.RSO	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	W.EndS
T.RSO	MaxRSO=1 & Collision	MaxRSO=3 Collision=FALSE RepeatASO=TRUE Phy_APPG.req(AGN)	W.AG
T.RSO	(MaxRSO=1 & not(Collision)) | (MaxRSO<>1 & NbRSO>=MaxRSO)	DL_ASO.ind(Collision, ListRSO)	W.EndS
T.RSO	NbRSO<MaxRSO	NbRSO=NbRSO+1	M.RSO
M.Send	exist_dl_data_req(DL_DATA.req(Pr=1, DSDU)) & NbChain < MaxChain	Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index= Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.Send	not(DL_DATA.req(Pr=1, _)) & exist_dl_data_req(DL_DATA.req(Pr=0, DSDU)) & NbChain < MaxChain	Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index= Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.Send	not(DL_DATA.req(_, _)) & NbChain < MaxChain	Pr=0 Fr="" Index= Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.Send	NbChain >= MaxChain	Phy_APPG.req(AGN)	W.AG

État initial	Condition de déclenchement	Ensemble d'actions	État final
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & is_text(Frame)	DL_DATA.ind(extract_prty(Frame), extract_text(Frame)) Confirm=incr(Confirm) Ack_expected=FALSE Index = 0	*M.Send*
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & not(is_text(Frame))	Ack_expected=FALSE Index = 0	*M.Send*
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & Index<=MaxRetry	Phy_DATA.req(Fr) Index=Index+1	M.Rec
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & Index>MaxRetry	DL_ABORT.ind(EL-2F) Phy_ABORT.req()	W.EndS
M.Rec	DL_ABORT.req(Strong=0) & not(DL_DATA.req(_, _)) & Ack_expected=FALSE	Phy_ABORT.req()	W.EndS
M.Rec	DL_ABORT.req(Strong=1)	Phy_ABORT.req()	W.EndS
M.Rec	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	W.EndS

Tableau 24 – Transitions d'état de *Link-E/D:* Station secondaire

État initial	Condition de déclenchement	Ensemble d'actions	État final
Initial	$true()	MaxRetry=2 FlagDSO=TRUE Discovered=FALSE Flag_alarm = FALSE	Stopped
Stopped	Phy_DATA.ind(Frame) & check_frame(Frame) & check_address(Frame)	ADP=extract_ADP(Frame) Com=command(Frame)	*T.Com*
Stopped	Phy_DATA.ind(Frame) & check_frame(Frame) & not(check_address(Frame))	Phy_ABORT.req()	Stopped
Stopped	Phy_DATA.ind(Frame) & not(check_frame(Frame))	$none()	Stopped
Stopped	DL_ALARM.req() & alarm_detection()	Phy_ABORT.req() Flag_alarm = TRUE Phy_ALARM.req()	Stopped
T.Com	Com=IB	FlagDSO=TRUE Discovered=FALSE Phy_ABORT.req()	Stopped
T.Com	Com=ASO & test_TABi(Frame, TAB)	Fr=concat(RSO, TAB, ADS) Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_RSO.req(Fr, window_RSO())	Stopped
T.Com	Com=ASO & not(test_TABi(Frame, TAB))	Phy_ABORT.req()	Stopped

État initial	Condition de déclenchement	Ensemble d'actions	État final
T.Com	is_data+(Frame) & is_text(Frame)	Ack_expected=FALSE Send="11"B Confirm="00"B DL_DATA.ind(extract_prty, extract_text(Frame))	*M.Send*
T.Com	is_data+(Frame) & not(is_text(Frame))	Ack_expected=FALSE Send="11"B Confirm="00"B	*M.Send*
M.Send	exist_dl_data_req(DL_DATA.req(Pr=1, DSDU))	Discovered = TRUE Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index=1 Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.Send	not(DL_DATA.req(Pr=1, _)) & exist_dl_data_req(DL_DATA.req(Pr=0, DSDU))	Discovered = TRUE Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index=1 Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.Send	not(DL_DATA.req(_, _))	Pr=0 Fr="" Index=1 Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & is_text(Frame)	stop_timer(T1) Confirm=incr(Confirm) Ack_expected=FALSE DL_DATA.ind(extract_prty, extract_text(Frame))	*M.Send*
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & not(is_text(Frame))	stop_timer(T1) Ack_expected=FALSE	*M.Send*
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & Index<=MaxRetry	stop_timer(T1) Phy_DATA.req(Fr) Index=Index+1	M.Rec
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & Index>MaxRetry	stop_timer(T1) DL_ABORT.ind(EL-2F) Phy_ABORT.req()	Stopped
M.Rec	DL_ABORT.req(Strong=0) & not(DL_DATA.req(_, _)) & Ack_expected=FALSE	stop_timer(T1) Phy_ABORT.req()	Stopped
M.Rec	DL_ALARM.req() & alarm_detection()	stop_timer(T1) DL_ABORT.ind(EL_1F) Phy_ABORT.req() Flag_alarm = TRUE Phy_ALARM.req()	Stopped

État initial	Condition de déclenchement	Ensemble d'actions	État final
M.Rec	DL_ABORT.req(Strong=1)	stop_timer(T1) Phy_ABORT.req()	Stopped
M.Rec	Phy_ABORT.ind(EP-1)	init_timer(T1)	M.Rec
M.Rec	Phy_ABORT.ind(ErrorNb) & ErrorNb <> EP-1	stop_timer(T1) DL_ABORT.ind(ErrorNb)	Stopped
M.Rec	time_out(T1)	DL_ABORT.ind(EL_3F)	Stopped

Tableau 25 – Signification des états mentionnés dans les tableaux précédents

État	Signification
Initial	Initialisation des variables de la couche
Stopped	Attente de la première demande de la couche supérieure ou de la première indication de la couche inférieure
W.AG (Wait for end of "Wakeup Call")	Attente de la fin d'un signal "Appel général" demandé
W.EndS (Wait for End of Session)	Attente de la fin d'une session
T.Req (Test Request)	Essai de la nature d'une demande en provenance d'une couche supérieure
M.RSO (Must receive RSO)	Attente d'une trame RSO après l'envoi d'une trame ASO
T.RSO (Test last RSO)	Vérification de la fin du dernier intervalle de temps pour la réception d'une trame RSO
M.Send (Must Send)	Une trame doit être envoyée (le champ Text peut être vide)
M.Rec (Must Receive)	Attente d'une réponse en provenance de la couche inférieure
T.Com (Test Command)	Essai du code de commande d'une trame reçue

Tableau 26 – Définition des procédures et des fonctions classées par ordre alphabétique

Procédure ou fonction	Définition
Alarm_detection()	Vérification que le mode Alarme est Actif
build_RSO(ListRSO, Frame)	Extraction des éléments (champs TAB et ADS) de la trame RSO reçue Frame et concaténation avec la précédente liste ListRSO
check_address(Frame)	Vérification que les adresses ADP et ADS sont reconnues selon les critères suivants: – la station est sensibilisée à l'ADP ou ADP = APG; – ADS=ADG si le code de commande est ASO ou IB, – ADS est l'adresse de la station secondaire si le code de commande n'est pas ASO ou IB
check_frame(Frame)	Vérification que la trame Frame reçue est correcte: – nombre d'octets supérieur ou égal à 11 et inférieur ou égal à 128; – CRC correct; – nombre d'octets compatible avec le champ Size; – code de commande connue
com(DATA+, Pr, Send, Confirm)	Concaténation des champs binaires correspondants pour obtenir un code de commande spécifique
command(Frame)	Extraction de la valeur du code de commande de la trame Frame reçue
concat(Size, ADS, ADP, COM,Text) or concat(Frame, CRC)	Concaténation des champs Size, ADS, ADP, COM et Text ou concaténation du CRC à la fin de la trame Frame
context(ADS, ADP, TypeAG)	Extraction des valeurs correspondantes du contexte de communication
crc(Frame)	Calcul du CRC de la trame Frame à émettre
create_alarm(TPDU)	Calcul d'un TPDU avec STSAP = 0, DTSAP = 0 et un UnsolicitedReqPDU avec: client-type = FFFF, serveridentifier = 0, object-name = FFFF variable type = boolean, value = TRUE
exist_dl_data_req(DL_DATA.req(Pr, DSDU))	Consommation d'un événement DL_DATA.req(Pr, DSDU)
exist_dl_req()	Vérification de l'existence d'un événement DL_IB.req(), DL_ASO.req(DSDU) ou DL_DATA.req(Pr, DSDU) et vérification de la compatibilité avec les adresses ADS et ADP du contexte de communication
exist_dl_req(DL_IB.req()) or exist_dl_req(DL_ASO.req(DSDU))	Consommation d'un événement DL_IB.req() ou DL_ASO.req(DSDU)
extract_ADP(Frame)	Si la valeur d'ADP utilisée dans la trame est différente de APG ou bien s'il s'agit de APG mais que la liste des valeurs ADP auxquelles est sensibilisée la Station Secondaire est vide, extraction de cette valeur, sinon extraction de la première valeur ADP à laquelle est sensibilisée la Station Secondaire
extract_prty(Frame)	Extraction du champ Priority de la trame Frame reçue
extract_text(Frame)	Extraction du champ Text de la trame Frame reçue
init(TypeAG)	Met Index à MaxRetry si TypeAG vaut AGT, à 0 sinon
init_incrChain()	Met IncrChain à 0 si les alarmes ne sont pas prises en charge, à 1 sinon
init_timer(T1)	Armement du temps de réveil T1
is_ack(Frame)	Vérification que la trame Frame reçue contient un champ Confirm égal au champ Send de la dernière trame émise
is_data+(Frame)	Vérification que la trame Frame reçue contient un champ DATA+ correct ("111" B)
is_text(Frame)	Vérification que la trame Frame reçue contient un champ de données Text non vide et que le champ Send est égal au complément à un du champ Confirm de la dernière trame émise.
size(Frame)	Calcul de la taille de la trame Frame reçue

Procédure ou fonction	Définition
size_frame(DSDU)	Calcul de la taille de la trame à construire à partir de l'unité de données DSDU (taille de DSDU+11)
stop_timer(T1)	Désarmement du temps de réveil T1
test_TABi(Frame, TAB)	Si le premier des TABi contenus dans la trame ASO Frame vaut 00, vérification que la variable Discovered est à FAUX et vérification, après tirage d'un nombre aléatoire entre 0 et 100, que ce nombre entier est inférieur à la probabilité de réponse souhaitée au deuxième des TABi. Dans ce cas, la valeur 00 est mémorisée dans la variable TAB; Si le premier TABi contenu dans la trame ASO reçue vaut FF, vérification que la variable Flag_alarm est à VRAI et dans ce cas affectation de la valeur FAUX à la variable Flag_alarm et mémorisation de la valeur FF dans la variable TAB; Si le premier TABi contenu dans la trame Frame ASO reçue ne vaut ni 00 ni FF, vérification que la variable FlagDSO est à VRAI, que la Station Secondaire est sensibilisée à l'un des TABi contenus dans la trame Frame ASO reçue. Dans ce cas, mémorisation de la première de ces valeurs dans la variable TAB
time_out(T1)	Armement du temps de réveil T1
window_RSO()	Fourniture d'une valeur aléatoire entière comprise entre 0 et MaxRSO-1 utilisée comme numéro de l'intervalle de temps RSO au cours duquel la station doit répondre (voir l'Annexe F)

6.2.6 Liste et traitement des erreurs

Les erreurs sont répertoriées par les codes suivants:

EL = erreur de la couche *Liaison de données*

– = séparateur

N = numéro de l'erreur

F = erreur fatale

Les erreurs relatives à *Link-E/D* sont indiquées dans le Tableau 27.

Tableau 27 – Tableau récapitulatif des erreurs

EL-1F	DL_ALARM.req() reçue durant une association
	Cette requête conduit à réinitialiser la couche *Liaison de données* après avoir demandé à la couche *Physique* de transmettre une alarme
EL-2F	Réponse incorrecte de la Station Secondaire après MaxRetry répétitions de la requête
	Cette erreur conduit à réinitialiser la couche *Liaison de données* après avoir informé la couche *Application* et provoqué l'arrêt de la couche *Physique*
EL-3F	Fin de communication après un silence d'une durée T1
	Cette erreur conduit à réinitialiser la couche *Liaison de données* après avoir informé la couche *Application* et provoqué l'arrêt de la couche *Physique*

Toute occurrence de l'une de ces erreurs est remontée localement au moyen de la primitive de service DL_ABORT.ind. La liste complète des numéros d'erreur fatale est fournie à l'Annexe C.

6.3 Couche Application

6.3.1 Généralités

Les spécifications de la couche *Application* sont données dans l'IEC 62056-51. Le présent paragraphe clarifie simplement le profil utilisé pour le profil d'échange de données par bus local avec DLMS.

6.3.2 Sous-couche Transport

La valeur du nombre MaxPktSize (voir l'IEC 62056-51), taille maximale du champ *Packet*, doit être établie à 114.

6.3.3 Sous-couche Application

Comme cela est indiqué dans l'IEC 62056-51, les fonctions client_connect et server_connect doivent être précisées en fonction du support de communication utilisé. Pour le profil d'échange de données par bus local avec DLMS, la gestion du service non sollicité n'étant pas prise en charge, la fonction server_connect n'est pas acceptée. La fonction client_connect est définie dans le Tableau 28.

Tableau 28 – Définition de la fonction client_connect

Procédure ou fonction	Définition
client_connect(Ads, Adp)	S'il n'existe aucune association d'application active, la fonction établit les paramètres du contexte de communication: ADS, ADP et TypeAG, utilisés par les couches inférieures. La fonction est transparente s'il y a déjà une association d'application active avec les mêmes adresses (ADP, ADS). La fonction échoue s'il existe déjà une association d'application avec des adresses (ADP, ADS) différentes.

7 Échange de données par bus local avec DLMS/COSEM

7.1 Modèle

Le profil avec DLMS/COSEM est différent des deux autres par le fait que la couche Application est la couche Application DLMS/COSEM spécifiée dans l'IEC 62056-5-3. Elle permet ainsi aux équipements qui mettent en œuvre la couche application DLMS/COSEM de participer à l'échange de données sur le bus Euridis.

Une autre différence est la présence d'une couche *Transport* et d'une couche *Gestion du Support*.

7.2 Couche Physique

7.2.1 Généralités

Le protocole de la couche Physique avec DLMS/COSEM est identique au protocole de la couche physique avec ou sans DLMS jusqu'à la fin de la négociation correcte de la vitesse de transmission incluse. A l'issue satisfaisante de la phase de négociation de la vitesse, la couche physique DLMS/COSEM s'applique. Elle ne diffère de la couche Physique avec ou sans DLMS, que par la vitesse de transmission, la valeur de MaxIndex qui doit être de 255 et la modification des valeurs des temps d'expiration TOL et TA10.

Après un signal “Appel général”, les communications se déroulent en asynchrone et en semi-duplex à 1 200 bauds, 8 bits sans parité sur le bus durant toute la période de communication sans négociation de la vitesse. Après une négociation de la vitesse satisfaisante, la communication se déroule en asynchrone et semi-duplex, 8 bits sans parité à la vitesse négociée.

Cette négociation de la vitesse a lieu uniquement pour les équipements non téléalimentés. Pour les équipements téléalimentés, afin de respecter les contraintes de consommation, la vitesse de communication demeure à 1 200 bauds durant toute la durée de la communication et MaxIndex à 128 octets. Le fonctionnement DLMS/COSEM sous Euridis demeure possible avec ces paramètres initiaux.

Pour les équipements non téléalimentés, le fonctionnement avec une couche Application DLMS/COSEM est possible avec ou sans changement de vitesse. Dans le cas où l'application décide d'effectuer un changement de vitesse, les paramètres relatifs au changement de vitesse s'appliquent avant l'établissement des associations d'application.

7.2.2 Paramètres de Physique

La communication démarre toujours à la vitesse de 1 200 bauds sans parité, un bit d'arrêt. La longueur maximale de la trame est de 128 octets.

Après la négociation de la vitesse, la nouvelle vitesse négociée est appliquée. La longueur maximale de la trame MaxIndex devient 255 octets.

La valeur du nombre maximal MaxRSO d'intervalles de temps RSO pour le traitement d'une trame “Appel des stations oubliées” est fixée à 3.

Le temps d'attente d'expiration maximal TOL d'une réponse de la couche supérieure est portée à 1 s.

7.2.3 Négociation de la vitesse

La gestion de la négociation de la vitesse relève de la couche *Gestion du Support.* La couche physique est informée de la nouvelle vitesse à appliquer, avec ses conséquences sur MaxIndex et TOL. Comme conséquence de la modification de la valeur de TOL, après une négociation de la vitesse, le temps d'attente maximal du premier octet reçu d'une trame est porté à une valeur supérieure à TOL, en fonction de l'application. Par défaut cette valeur est établie à 1 100 ms.

7.2.4 Services et primitives de service de Physical-E/COSEM

Le protocole *Physical-E/COSEM* comprend les services et primitives de service indiqués dans le Tableau 29.

Tableau 29 – Services et primitives de services de Physical-E/COSEM

Service	Primitive de service
Phy_DATA	Phy_DATA.req(Frame) Phy_DATA.ind(Frame)
Phy_UNACK	Phy_UNACK.req(Frame)
Phy_APPG	Phy_APPG.req(TypeAG) Phy_APPG.ind()
Phy_ASO	Phy_ASO.req(Frame) Phy_ASO.ind(Frame)
Phy_RSO	Phy_RSO.req(Frame, Window)
Phy_COLL	Phy_COLL.ind()
Phy_ALARM	Phy_ALARM_req() Phy_ALARM_ind()
Phy_ABORT	Phy_ABORT.req() Phy_ABORT.ind(ErrorNb)
Phy_SETUP	PHY_SETUP.req(params)

Le rôle attribué à chaque primitive est le suivant:

- Phy_DATA.req(Frame) permet à la couche *Liaison de données* de demander à la couche *Physique* l'émission d'une trame Frame;
- Phy_DATA.ind(Frame) permet à la couche *Physique* d'informer la couche *Liaison de données* qu'une trame Frame est disponible;
- Phy_UNACK.req(Frame) permet à la couche *Liaison de données* de demander à la couche *Physique* l'émission d'une trame Frame sans attendre d'acquittement;
- Phy_APPG.req(TypeAG) permet à la couche *Liaison de données* de demander à la couche *Physique* l'émission d'un signal "Appel général". La durée TypeAG du signal est soit AGN soit AGT;
- Phy_APPG.ind() permet à la couche *Physique* d'informer la couche *Liaison de données* de la fin d'émission d'un signal "Appel général";
- Phy_ASO.req(Frame) permet à la couche *Liaison de données* de demander à la couche *Physique* l'émission d'une trame "Appel des Stations Oubliées";
- Phy_ASO.ind(Frame) permet à la couche *Physique* d'informer la couche *Liaison de données* qu'une trame Frame a été reçue au cours de l'un des intervalles de temps des stations oubliées;
- Phy_RSO.req(Frame, Window) permet à la couche *Liaison de données* de demander à la couche *Physique* l'émission d'une trame Frame d'Appel des Stations Oubliées dans le numéro d'intervalle de temps Window;
- Phy_COLL.ind() permet à la couche *Physique* d'informer la couche *Liaison de données* qu'une collision a été détectée au cours de l'un des intervalles de temps des stations oubliées;
- Phy_ALARM.req() permet à la couche *Liaison de données* de demander à la couche *Physique* l'émission d'un signal "Alarme";
- Phy_ALARM.ind() permet à la couche *Physique* d'informer la couche *Liaison de données* de l'arrivée d'une alarme;
- Phy_ABORT.req() permet à la couche *Liaison de données* de demander à la couche *Physique* de mettre fin à son activité;
- Phy_ABORT.ind(ErrorNb) permet à la couche *Physique* d'informer la couche *Liaison de données* de l'occurrence d'une erreur fatale repérée par le numéro ErrorNb.
- PHY_SETUP.req(params) permet à la couche *Liaison de données* de demander à la couche *Physique* de se reconfigurer en fonction des paramètres liés à la négociation de la vitesse.

7.2.5 Transitions d'état

Les transitions d'état de *E/COSEM Physical* sont indiquées dans le Tableau 30, le Tableau 31, le Tableau 32 et le Tableau 33.

Tableau 30 – Transitions d'état de *Physical-E/COSEM:* Station Primaire

État initial	Conditions de déclenchement	Actions	État final
Initial	$true()	MaxRSO=3 MaxIndex=128 Collision=FALSE SessionAGT=FALSE wait_time(TICB) Set_params(1200, TOL=100ms, TA10=120ms)	Stopped
Stopped	Phy_APPG.req(AG) & AG=AGN	stop_timer(TOAG) FlagAbort=FALSE TypeAG=AGN send_AG(TypeAG)	W.AG
Stopped	Phy_APPG.req(AG) & AG=AGT	SessionAGT=TRUE FlagAbort=FALSE TypeAG=AGT send_AG(TypeAG)	W.AG
Stopped	time_out(TOAG)	Phy_ABORT.ind(EP-2) SessionAGT=FALSE	*Initial*
Stopped	Phy_ABORT.req()	$none()	*Initial*
Stopped	data-carrier_on	init_timer(TAB) init_timer (TASB)	W.ETABS
W.ETABS	data_carrier_off	stop_timer(TASB) stop_timer(TAB)	*Initial*
W.ETABS	time_out(TAB)	Phy_ABORT.ind(EP-3) Phy_ALARM.ind()	W.TASB
W.AG	AG_sent_event	Phy_APPG.ind() init_timer(TEMPO)	W.TAB
W.AG	Phy_ABORT.req()	FlagAbort=TRUE	W.AG
W.TAB	data-carrier_on	Carrier = TRUE init_timer(TAB) init_timer (TASB)	W.TAB
W.TAB	data-carrier_off	Carrier = FALSE stop_timer(TAB) stop_timer (TASB)	W.TAB
W.TAB	time_out(TEMPO) & not(FlagAbort) & not(Carrier)	init_timer(TOL)	M.Send
W.TAB	time_out(TEMPO) & FlagAbort & not(Carrier)	wait_time (TOL)	*T.Session*
W.TAB	time_out(TEMPO) & Carrier	init_timer(TOL)	W.ETAB
W.TAB	Phy_ABORT.req()	FlagAbort=TRUE	W.TAB
W.ETAB	time_out(TAB)	Phy_ABORT.ind(EP-3) Phy_ALARM.ind() stop_timer(TOL)	W.TASB
W.ETAB	data_carrier_off & not(FlagAbort)	stop_timer(TAB) stop_timer (TASB)	M.Send
W.ETAB	data_carrier_off & FlagAbort	stop_timer(TAB) stop_timer (TASB)	W.TOL
W.ETAB	Phy_ABORT.req()	FlagAbort=TRUE	W.ETAB
W.TASB	time_out(TASB)	$none()	*Initial*
W.TOL	time_out(TOL)	$none()	*T.Session*
M.Send	Phy_DATA.req(Frame)	Service=NORMAL	*SendFirst*

État initial	Conditions de déclenchement	Actions	État final
M.Send	Phy_UNACK.req(Frame)	Service=UNACKNOWLEDGED	*SendFirst*
M.Send	Phy_ASO.req(Frame)	Service=ASO	*SendFirst*
M.Send	Phy_ABORT.req()	$none()	M.Send
M.Send	time_out(TOL)	$none()	*T.Session*
M.Send	PHY_SETUP(params)	Set_params(new baudrate, TOL=1000ms TA10=1100ms,) MaxIndex=255	M.Send
T.Session	SessionAGT=TRUE	init_timer(TOAG) Phy_ABORT.ind(EP-1) wait_time(TEMPO)	*Initial*
T.Session	SessionAGT=FALSE	Phy_ABORT.ind(EP-1) wait_time(TEMPO)	*Initial*
SendFirst	$true()	stop_timer(TOL) Size=size(Frame) Index=1 send_octet(Frame,Index) Size=Size-1 init_timer(TOE)	Sending
Sending	octet_sent_event & Size>0	Index=Index+1 send_octet(Frame, Index) Size=Size-1	Sending
Sending	octet_sent_event & Size=0	stop_timer(TOE) wait_time(TAO) Index=1 Frame=""	*Answer*
Sending	Phy_ABORT.req()	stop_timer(TOE) wait_time(TAO) init_timer(TA1O) FlagAbort=TRUE	M.Rec
Sending	time_out(TOE)	Phy_ABORT.ind(EP-3F) wait_time(TAO) init_timer(TA1O) FlagAbort=TRUE	M.Rec
Answer	Service=NORMAL I Service=UNACKNOWLEDGED	init_timer(TA1O)	M.Rec
Answer	Service=ASO	WinRSO=1 init_timer(TARSO) init_timer(TA1O)	M.Rec
M.Rec	octet_received_event	stop_timer(TA1O) Index=Index+1 read_data(RecB) concat(Frame, RecB) init_timer(TAO)	Receiving
M.Rec	Collision_detected_event	stop_timer(TA1O) Collision=TRUE init_timer(TAO)	Receiving
M.Rec	time_out(TA1O)	$none()	*Received*
M.Rec	Phy_ABORT.req()	FlagAbort=TRUE	M.Rec
Receiving	octet_received_event & Index<=MaxIndex	stop_timer(TAO) Index=Index+1 read_data(RecB) concat(Frame, RecB) init_timer(TAO)	Receiving
Receiving	octet_received_event & Index>MaxIndex	Phy_ABORT.ind(EP-4F) wait_time(TAO) FlagAbort=TRUE	*Received*
Receiving	Collision_detected_event	stop_timer(TAO) Collision=TRUE init_timer(TAO)	Receiving

État initial	Conditions de déclenchement	Actions	État final
Receiving	time_out(TAO)	$none()	*Received*
Receiving	time_out(TARSO)	Phy_ABORT.ind(EP-5F) wait_time(TAO) FlagAbort=TRUE	*Received*
Receiving	Phy_ABORT.req()	Flagabort = TRUE	Receiving
Received	Service=NORMAL & not(Flagabort)	Phy_DATA.ind(Frame) init_timer(TOL)	M.Send
Received	(Service=NORMAL & Flagabort) | Service=UNACKNOWLEDGED	wait_time(TOL)	*T.Session*
Received	Service=ASO & Collision & not(Flagabort)	Phy_COLL.ind() Collision=FALSE	*T.RSO*
Received	Service=ASO & not(Collision) & not(Flagabort)	Phy_ASO.ind(Frame)	*T.RSO*
Received	Service=ASO & Flagabort	$none()	*T.RSO*
T.RSO	(TypeAG=AGT) I (WinRSO>=MaxRSO) & (TypeAG=AGN)	stop_timer(TARSO)	*T.Session*
T.RSO	(WinRSO<MaxRSO) & (TypeAG=AGN)	Index=1 Frame=""	W.RSO
W.RSO	time_out(TARSO)	WinRSO=WinRSO+1 init_timer(TARSO) init_timer(TA1O)	M.Rec
W.RSO	Phy_ABORT.req()	Flagabort=TRUE	W.RSO

Tableau 31 – Transitions d'état de la gestion d'alimentation en énergie (Station Secondaire téléalimentée seulement)

État initial	Condition de déclenchement	Ensemble d'actions	État final
Initial	alarm_detection()	Flagalarm=TRUE FlagSendAlarm =FALSE station_power(ON) Set_params(1200, TOL=100ms, TA10=120ms) MaxIndex=128	Stopped
Initial	not(alarm_detection())	Flagalarm=FALSE Set_params(1200, TOL=100ms, TA10=120ms) MaxIndex=128	Stopped
Stopped	occur(cpt_carrier_on) & Flagalarm	init_timer(TVASB)	W.TVASB2
Stopped	occur(data_carrier_on)	init_timer(TOSEUIL) init_timer(TAGT)	W.TOSEUIL
W.TOSEUIL	time_out(TOSEUIL)& not(Flagalarm)	station_power(ON)	W.AGT
W.TOSEUIL	occur(data_carrier_off) & not(Flagalarm)	stop_timer(TOSEUIL) stop_timer(TAGT)	*Initial*
W.TOSEUIL	time_out(TOSEUIL) & Flagalarm	station_signal(ON) Tend = TOAG	W.AGT
W.TOSEUIL	occur(data_carrier_off) & Flagalarm	stop_timer(TOSEUIL) stop_timer(TAGT) Tend = TOAGN init_timer(Tend)	Hide
W.TOSEUIL	occur(cpt_carrier_on) & Flagalarm	init_timer(TVASB)	W.TVASB1
W.AGT	occur(data_carrier_off)	stop_timer(TAGT) init_timer(TOAPPEL)	W.Sel

État initial	Condition de déclenchement	Ensemble d'actions	État final
W.AGT	time_out(TAGT) & not(Flagalarm)	station_power(OFF)	*Initial*
W.AGT	time_out(TAGT) & Flagalarm	init_timer(Tend)	Hide
W.Sel	occur(octet_received_event)	stop_timer(TOAPPEL) init_timer(TOBAVARD) init_timer(TAO)	Select
W.Sel	time_out(TOAPPEL) & not(Flagalarm)	station_power(OFF)	*Initial*
W.Sel	time_out(TOAPPEL) & Flagalarm	station_signal(OFF)	*Initial*
W.Sel	occur(cpt_carrier_on) & Flagalarm & not(FlagSendalarm)	init_timer(TVASB)	W.TVASB1
Select	occur(octet_received_event)	stop_timer(TAO) init_timer(TAO)	Select
Select	time_out(TAO)	stop_timer(TOBAVARD) init_timer(TOPRE)	W.Answer
Select	time_out(TOBAVARD) & not(Flagalarm)	stop_timer(TAO) station_power(OFF)	*Initial*
Select	time_out(TOBAVARD) & Flagalarm	stop_timer(TAO) init_timer(Tend)	Hide
W.Answer	occur(octet_sent_event)	stop_timer(TOPRE) init_timer(Tend)	Hide
W.Answer	time_out(TOPRE) & not(Flagalarm)	station_power(OFF)	*Initial*
W.Answer	time_out(TOPRE) & Flagalarm	init_timer(Tend)	Hide
W.Answer	occur(cpt_carrier_on) & Flagalarm & not(FlagSendalarm)	init_timer(TVASB)	W.TVASB1
Hide	occur(octet_received_event) | occur(octet_sent_event) I (occur(data_carrier_on) & not(FlagSendAlarm))	stop_timer(Tend) init_timer(Tend)	Hide
Hide	occur(data_carrier_on) & FlagSendAlarm	stop_timer(Tend)	W.AGend
Hide	time_out(Tend) & not(Flagalarm)	station_power(OFF)	*Initial*
Hide	time_out(Tend) & Flagalarm & not(FlagSendAlarm)	station_signal(OFF)	*Initial*
Hide	time_out(Tend) & Flagalarm & FlagSendAlarm	Send_AG(AGN)	W.AB
Hide	occur(cpt_carrier_on) & Flagalarm & not(FlagSendalarm)	init_timer(TVASB)	W.TVASB1
W.AGend	occur(data_carrier_off)	wait_time(TOALR) Send_AG(AGN)	W.AB
W.TVASB1	occur(cpt_carrier_off)	stop_timer(TVASB) init_timer(Tend)	Hide
W.TVASB1	time_out(TVASB)	FlagSendAlarm = TRUE init_timer(Tend)	Hide
W.TVASB1	time_out(Tend)	$none()	W.TVASB2
W.TVASB2	occur(cpt_carrier_off)	stop_timer(TVASB) station_signal(OFF)	*Initial*
W.TVASB2	occur(data_carrier_on)	$none()	W.TVASB1
W.TVASB2	time_out(TVASB)	Send_AG(AGN)	W.AB
W.AB	AG_sent_event	FlagSendAlarm = FALSE station_signal(OFF)	*Initial*

Tableau 32 – Transitions d'état de *Physical-E/COSEM:* Station secondaire

État initial	Condition de déclenchement	Ensemble d'actions	État final
Initial	energized()	MaxIndex=128 FlagRSO=FALSE FirstWinRSO=FALSE Setup_params(1200, TOL=100ms, TA10=160ms) MaxIndex=128,	Stopped
Initial	not(energized())	MaxIndex=18 FlagRSO=FALSE FirstWinRSO=TRUE Setup_params(1200, TOL=100ms, TA10=120ms)	Stopped
Stopped	AG_received_event	Stop_timer(TOAG) init_timer(TA1O)	M.Rec
Stopped	Phy_ALARM.req()	TypeAG=ASB Send_AG(TypeAG)	W.ASB
Stopped	time_out(TOAG)	MaxIndex=18 FirstWinRSO=TRUE	*Initial*
M.Rec	octet_received_event	Stop_timer(TA1O) Index=2 Frame="" Read_data(RecB) Concat(Frame, RecB) Init_timer(TAO)	Receiving
M.Rec	time_out(TA1O)	Phy_ABORT(EP-1)	*WTOAG*
M.Rec	Phy_ABORT.req()	Stop_timer(TA1O)	*WTOAG*
M.Rec	PHY_SETUP(params)	Setup_params(new baudrate, TOL=1000ms, TA10=1100ms) See NOTE MaxIndex=255,	M.Rec
Receiving	octet_received_event & Index<=MaxIndex	Stop_timer(TAO) Index=Index+1 Read_data(RecB) Concat(Frame, RecB) Init_timer(TAO)	Receiving
Receiving	octet_received_event & Index>MaxIndex	Stop_timer(TAO) Phy_ABORT.ind(EP-4F)	*WTOAG*
Receiving	time_out(TAO)	Phy_DATA.ind(Frame) Init_timer(TOL)	M.Send
Receiving	Phy_ABORT.req()	Stop_timer(TAO)	*WTOAG*
M.Send	Phy_DATA.req(Frame)	Stop_timer(TOL) Size=size(Frame) Index=1 Send_octet(Frame, Index) Size=Size-1 Init_timer(TOE)	Sending
M.Send	Phy_RSO.req(Frame, Window)	Stop_timer(TOL) Wait_window(FirstWinRSO, Window) FirstWinRSO=FALSE Size=size(Frame) Index=1 Send_octet(Frame, Index) Size=Size-1 FlagRSO=TRUE Init_timer(TOE)	Sending
M.Send	time_out(TOL)	Init_timer(TA1O)	M.Rec
M.Send	Phy_ABORT.req()	Stop_timer(TOL)	*WTOAG*

État initial	Condition de déclenchement	Ensemble d'actions	État final
Sending	octet_sent_event & Size>0	Index=Index+1 Send_octet(Frame, Index) Size=Size-1	Sending
Sending	octet_sent_event & Size=0 & not(FlagRSO)	Stop_timer(TOE) init_timer(TA1O)	M.Rec
Sending	octet_sent_event & Size=0 & FlagRSO	Stop_timer(TOE) Wait_time(TAO) FlagRSO=FALSE	*WTOAG*
Sending	Phy_ABORT.req()	Stop_timer(TOE)	*WTOAG*
Sending	time_out(TOE)	Phy_ABORT.ind(EP-3F)	*WTOAG*
W.ASB	time_out(TOAG)	MaxIndex=18 FirstWinRSO=TRUE	W.ASB
W.ASB	AG_sent_event	$none()	*Initial*
WTOAG	Not(energized)	init_timer(TOAG)	*Initial*
WTOAG	energized	$none()	*Initial*

NOTE Certains systèmes d'exploitation n'autorisent pas la modification du temps d'expiration lorsque le temporisateur lié à ce temps d'expiration est en cours. Ces dispositifs peuvent actualiser les valeurs du temps d'expiration uniquement lors de la séquence de réception suivante.

Tableau 33 – Signification des états mentionnés dans les tableaux précédents

État	Définition
Initial	Initialisation des variables de la couche
Stopped	État d'attente d'un signal "Appel général"
W.ETABS (Wait for end of " Alarm-Bus ")	État d'attente de la fin d'un signal "Alarme-Bus" reçu dans l'état Stopped
W.AG (Wait for end of " Wakeup Call ")	État d'attente de la fin de l'émission d'un signal "Appel général"
W.TAB (Wait " Alarm-Bus ")	État d'attente d'un signal "Alarme-Bus" durant le retard de sécurité en fin d'émission d'un signal "Appel général"
W.ETAB (Wait for end of " Alarm-Bus ")	État d'attente de la fin d'un signal "Alarme-Bus" reçu après l'émission d'un signal "Appel général"
W.TASB	Attente du déclenchement du temps de réveil TASB après le début de la réception d'un signal "Alarme-Bus"
W.TOL	Attente du déclenchement du temps de réveil TOL
M.Send (Must Send)	État initial de l'émetteur, attente d'une trame à émettre
T.Session	Vérification du type de session (avec Station Secondaire alimentée ou téléalimentée)
SendFirst	Envoi du premier octet de la trame à émettre
Sending	État récurrent de l'émetteur, émission octet par octet
Answer	Branchement en fonction du service demandé
M.Rec (Must Receive)	État initial du récepteur, attente du premier octet d'une trame
Receiving	État récurrent du récepteur, réception octet par octet
Received	Traitement de la trame reçue
T.RSO (Test last RSO)	Vérification de la fin du dernier intervalle de temps pour la réception d'une trame RSO

État	Définition
W.RSO (Wait for end of an RSO time slot)	Attente de la fin d'un intervalle de temps pour la réception d'une trame RSO
W.ASB	Attente de la fin d'émission d'un signal "Alarme Bus-Secondaire"
W.TOAG	Initialisation du temporisateur de fin de session TOAG si nécessaire
W.TOSEUIL	Attente du déclenchement du temps de réveil TOSEUIL
W.AGT	Attente d'un signal "Appel général" AGT
W.Sel (Wait for preSelection)	Attente d'une trame de présélection
Select	Réception d'une trame de présélection
W.Answer	Attente d'une trame de réponse en provenance d'une station sélectionnée
Hide	Attente de la fin d'une sélection
W.Agend	Attente de la fin de la réception d'un AG
W.TVASB1	Attente du déclenchement du temps de réveil TVASB pour un signal "Alarme Bus-Secondaire" durant une session
W.TVASB2	Attente du déclenchement du temps de réveil TVASB pour un signal "Alarme Bus-Secondaire" à la fin d'une session
W.AB	Attente de la fin d'émission d'un signal "Alarme-Bus"

Tableau 34 – Définition des procédures, des fonctions et des événements classés par ordre alphabétique

Procédure, fonction ou événement	Définition
AG_received_event	Événement issu du modem qui informe de la détection d'un signal "Appel général" AGN
AG_sent_event	Événement issu du modem qui informe de la fin de l'émission d'un signal "Appel général"
alarm_detection()	Vérification que la station a son mode alarme à Actif
collision_detected_event	Événement issu du modem qui informe de la détection d'une trame erronée sur réception d'un octet
concat(Frame, RecB)	Concaténation de l'octet RecB dans la trame Frame en cours de constitution
data_carrier_on, data_carrier_off	Occurrence de la détection de l'apparition ou de la disparition de la porteuse sur le bus
energized()	Vérification que la station est alimentée
init_timer(TOAPPEL), init_timer(TOSEUIL), init_timer(TAGT), init_timer(TOBAVARD), init_timer(TOPRE), init_timer(TOL), init_timer(TOE), init_timer(TAO), init_timer(TA1O), init_timer(TARSO) init_timer(TOAG), init_timer(TVASB) or init_timer(TAB)	Armement du temps de réveil TOAPPEL, TOSEUIL, TAGT, TOBAVARD, TOPRE, TOL, TOE, TAO, TA1O, TARSO, TOAG, TVASB ou TAB
occur(cpt_carrier_on), occur(cpt_carrier_off), occur(data_carrier_on), occur(data_carrier_off), occur(octet_received_event) or occur(octet_sent_event)	Occurrence (signalisation sans consommation) de la détection de l'apparition ou de la disparition de la porteuse sur le bus secondaire, de la détection de l'apparition de la porteuse sur le bus, de la disparition de la porteuse, de la réception d'un octet ou de l'émission d'un octet
octet_received_event	Événement issu du modem qui informe qu'un octet a été reçu

Procédure, fonction ou événement	Définition
octet_sent_event	Événement issu du modem qui informe qu'un octet a été émis
read_data(RecB)	Traitement de l'événement octet_received_event par lecture de l'octet RecB reçu (les bits sont transmis dans un ordre croissant)
send_AG(TypeAG)	Demande au modem d'effectuer l'émission d'un signal "Appel général" d'une durée TypeAG (AGN ou AGT)
send_octet(Frame, Index)	Émission de l'octet de rang Index dans la trame Frame (les bits sont transmis dans un ordre croissant)
Setup_params(baudrate, TOL, TA10)	Positionnement des paramètres baudrate, TOL et TA10.
size(Frame)	Calcul du nombre d'octets de la trame Frame
station_power(ON) or station_power(OFF)	Met en marche ou à l'arrêt l'alimentation en énergie du dispositif
station_signal(ON) or station_signal(OFF)	Met en marche ou à l'arrêt l'émission de signal vers le dispositif sur le bus secondaire
stop_timer(TOAPPEL), stop_timer(TOSEUIL), stop_timer(TAGT), stop_timer(TOBAVARD), stop_timer(TOPRE), stop_timer(TOL), stop_timer(TOE), stop_timer(TAO), stop_timer(TA1O), stop_timer(TVASB) or stop_timer(TAB)	Désarmement du temps de réveil TOAPPEL, TOSEUIL, TAGT, TOBAVARD, TOPRE, TOL, TOE, TAO, TA1O, TVASB ou TAB
stop_timer(TOAG) or stop_timer(TARSO)	Désarmement du temps de réveil TOAGT ou TARSO uniquement si elle a été préalablement armée
time_out(TOAPPEL), time_out(TOSEUIL), time_out(TAGT), time_out(TOBAVARD), time_out(TOPRE), time_out(TOL), time_out(TOE), time_out(TAO), time_out(TA1O), time_out(TARSO), time_out(TOAG), time_out(TVASB) or stop_timer(TAB)	Déclenchement du temps de réveil TOAPPEL, TOSEUIL, TAGT, TOBAVARD, TOPRE, TOL, TOE, TAO, TA1O, TARSO, TOAG, TVASB ou TAB
wait_time(TAO), wait_time(TICB), wait_time(TOL) or wait_time(TOALR)	Retard calculé pendant le temps TAO, TICB, TOL ou TOALR
wait_window(FirstWinRSO, Window)	Temps d'attente calculé de la façon suivante: FirstWinRSO=VRAI ou Window=0 ==> 0 ms FirstWinRSO=FAUX et Window>0 ==> 40 ms + (TARSO*Window) ms (Le retard de 40 ms garantit que l'émission a lieu dans l'intervalle de temps prévu)

Les erreurs relatives à *E/COSEM* sont indiquées dans le Tableau 35.

Tableau 35 – Tableau récapitulatif des erreurs

EP-1	Temps de réveil TOL (Station Primaire) écoulé avant que la couche *Liaison de données* n'ait demandé l'envoi d'une trame, ou délai TA10 (Station Secondaire) écoulé avant la réception d'un caractère en provenance de la Station Primaire
	Cette erreur conduit à l'attente d'un signal "Appel général" après avoir informé la couche *Liaison de données*
EP-2	Temps de réveil TOAG écoulé avant un signal "Appel général"
	Cette erreur conduit à l'attente d'un signal "Appel général" après avoir informé la couche *Liaison de données*
EP-3	Réception d'une alarme
	Cette erreur conduit à réinitialiser la couche *Physique* après avoir informé la couche *Liaison de données*
EP-3F	Durée anormale d'émission constatée après que le temps de réveil TOE est écoulé
	Cette erreur conduit à réinitialiser la couche *Physique* après avoir informé la couche *Liaison de données*
EP-4F	Nombre d'octets reçus supérieur à MaxIndex (Émetteur trop bavard)
	Cette erreur conduit à réinitialiser la couche *Physique* après avoir informé la couche *Liaison de données*
EP-5F	Temps de réveil TARSO écoulé en recevant une trame RSO (Station Primaire seulement)
	Cette erreur conduit à réinitialiser la couche *Physique* après avoir informé la couche *Liaison de données*

Toute occurrence de l'une de ces erreurs est remontée localement au moyen de la primitive de service Phy_ABORT.ind. La liste complète des numéros d'erreur fatale est fournie à l'Annexe C.

7.3 Couche Liaison de données

7.3.1 Généralités

La couche *Liaison de données* utilisée dans les échanges de données par bus local avec DLMS/COSEM est fondée sur le même principe que la couche *Data Link E/D* utilisée lors des échanges de données avec DLMS. Elle n'en diffère que par son interaction avec les couches supérieures et le traitement de la négociation de la vitesse.

Au niveau supérieur, la couche *Liaison de données* interface donc la couche *Transport* et la couche *Gestion du support* de communication.

7.3.2 Identification des unités de données

La couche Liaison de données remet à la couche Transport DLMS/COSEM, toutes les PDU identifiées DATA+. Pour toutes les autres PDU, le destinataire est la couche de gestion du support qui reconnaît et traite les PDU connus, les PDU qui ne sont pas connus sont simplement ignorés. Voir Tableau 41 pour les commandes de Gestion du Support.

7.3.3 Rôle de la couche Liaison de données

La couche *Liaison de données* a pour but de:

- gérer la sérialisation et la désérialisation des données;
- synchroniser les trames en émission et réception;
- filtrer les trames en fonction des adresses primaire et secondaire;
- assurer une protection efficace contre les erreurs de transmission.

7.3.4 Gestion des échanges

Côté Émetteur, toutes les trames de données émises doivent faire l'objet par la station réceptrice, d'un acquittement positif avant l'émission de la trame de données suivante. Après l'envoi d'une trame et la réception de l'acquittement de la trame précédemment émise, la trame courante est transmise. Le nombre de réémissions est limité à MaxRetry. Au-delà de ce nombre, la communication est interrompue au niveau Liaison de données et la couche Transport en est informée de même que la couche Gestion du support.

À chaque réception de trame, il y a émission d'une trame de réponse dans un délai compatible avec le temps TOL géré par la couche Physique. Dans le cas où la couche Transport n'a pas de données à émettre disponibles, une DSDU avec un champ Text vide est envoyée, notifiant l'acquittement ou le non-acquittement de la DPDU reçue.

Le principe de gestion des acquittements/non-acquittements est identique à celui spécifié en 6.2.2.

7.3.5 Services et primitives de service de liaison de données

Les services de liaison de données sont indiqués dans le Tableau 36.

Tableau 36 – Services et primitives de services de liaison de données

Service	Primitive de service
DL_DATA	DL_DATA.req(Pr ,Service class, DSDU) DL_DATA.ind(Pr,Service class, DSDU)
DL_ALARM	DL_ALARM.req() DL_ALARM.ind()
DL_ABORT	DL_ABORT.req(Strong) DL_ABORT.ind(ErrorNb)
DL_IB	DL_IB.req() DL_IB.ind()
DL_Discover	DL_Discover.req() DL_Discover.ind()
DL_ChangeBaudrate	DL_ChangeBaudrate.req() DL_ChangeBaudrate.ind()
DL_PhysicalSetupParameters	DL_PhysicalSetup.req(params)

Le rôle attribué à chaque primitive est le suivant:

DL_DATA.req(Pr, Service_class, DSDU) permet à la couche supérieure (*Transport* ou *Gestion du Support*) de demander à la couche *Liaison de données* le transfert d'un paquet de données avec la priorité Pr[5], avec une classe service_class CONFIRMED (CONFIRME) ou UNCONFIRMED (NON CONFIRME). Dans la requête, le paramètre service_class concerne uniquement la station primaire. Lorsque service_class est UNCONFIRMED, la couche *Liaison de données* de la station primaire doit utiliser une adresse de destination en diffusion.

DL_DATA.ind(Pr, Service_class, DSDU) permet à la couche *Liaison de données* d'informer la couche supérieure concernée de l'arrivée d'un paquet de données DSDU avec la priorité Pr. Dans l'indication, le paramètre service_class concerne uniquement la station secondaire. Lorsque l'adresse de destination est une adresse en diffusion, la couche liaison de données de la station secondaire doit positionner le paramètre Service_class à UNCONFIRMED, pour la couche supérieure.

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5 Le niveau de priorité Pr différencie le traitement d'un service urgent tel que InformationReport (niveau Pr=1) d'un autre service DLMS (niveau Pr=0).

DL_ALARM.req() permet à la couche *Gestion du Support* de la station secondaire de demander à la couche *Liaison de données* l'envoi d'une alarme.

DL_ALARM.ind() permet à la couche *Liaison de données* de la station primaire d'avertir la couche *Gestion du Support* de la présence d'une alarme.

DL_ABORT.req(Strong[6]) permet aux couches supérieures de demander à la couche *Liaison de données* de mettre fin à son activité avec la priorité Strong.

DL_ABORT.ind(ErrorNb) permet à la couche *Liaison de données* d'informer la couche *Gestion du Support* de l'occurrence d'une erreur fatale repérée par le numéro ErrorNb.

DL_IB.req() permet à la couche *Gestion du Support* de la station primaire de demander à la couche *Liaison de données* l'initialisation du bus.

DL_IB.ind() permet à la couche *Liaison de données* de la station secondaire d'informer la couche *Gestion du Support* de la présence d'une initialisation de bus.

DL _Discover.req() permet à la couche *Gestion du Support* de demander à la couche *Liaison de données*, l'envoi d'une trame d'Appel des stations oubliées.

DL_Discover.ind() permet à la couche *Liaison de données* d'informer la couche *Gestion du Support* de la présence d'une trame d'appel des stations oubliées.

DL_ChangeBaudrate.req() permet à la couche *Gestion du Support* de demander à la couche *Liaison de données* l'envoi d'une trame de négociation de la vitesse.

DL_ChangeBaudrate.ind() permet à la couche *Liaison de données* d'informer la couche *Gestion du Support* de la présence d'une trame de négociation de la vitesse.

DL_PhysicalSetupParameters.req(Params) permet à la couche *Gestion du support* de demander à *Liaison de données* d'effectuer les modifications des paramètres liés au changement de vitesse. Ces paramètres sont constitués du baudrate négocié, du temps d'expiration TOL qui passe à une seconde, le temps d'expiration TA10 de 1 100 ms et MaxIndex qui passe de 128 octets à 255 octets.

7.3.6 Paramètres de Liaison de données

Les paramètres de Liaison de données sont les mêmes que pour la couche Liaison de données avec DLMS, voir 6.2.4.

A la fin de la procédure de changement du débit en bauds, du côté du dispositif primaire, la couche liaison de données gère un temps d'expiration TES (temps d'expiration End of Setup) d'une valeur de 50 ms, avant le traitement de toute nouvelle requête destinée au dispositif secondaire. Il s'agit de permettre aux deux équipements de positionner correctement leur UART.

7.3.7 Transitions d'état

Les transitions d'état de *DLMS/COSEM Data Link E/D* sont indiquées dans le Tableau 37, le Tableau 38, le Tableau 39 et le Tableau 40.

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6 Le niveau de priorité Strong différencie le traitement des erreurs fatales (Strong=1) de celui d'une autre demande de déconnexion physique (Strong=0) initialisée par la sous-couche *Application*.

Tableau 37 – Transitions d'état de *DLMS/COSEM Data Link-E/D*: Station Primaire

État initial	Conditions de déclenchement	Ensemble d'actions	État final
Initial	$true()	MaxRetry=2 MaxChain = 5 init_incrChain()	Stopped
Stopped	exist_dl_req()	NbChain = 0 MaxIndex=0 RepeatASO=FALSE context(ADP, ADS, TypeAG) init(TypeAG) Phy_APPG.req(TypeAG)	W.AG
Stopped	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	Stopped
Stopped	Phy_ALARM.ind()	DL_ALARM.ind()	Stopped
W.AG	Phy_APPG.ind() & not(RepeatASO) & NbChain = 0	$none()	*T.Req*
W.AG	Phy_APPG.ind() & not(RepeatASO) & NbChain <> 0	NbChain = 0	*M.Send*
W.AG	Phy_APPG.ind() & RepeatASO	RepeatASO=FALSE Phy_ASO.req(Fr)	M.RSO
W.AG	DL_ABORT.req(_)	Phy_ABORT.req()	W.EndS
W.EndS	(Phy_ABORT.ind(EP-2) & TypeAG=AGT) I (Phy_ABORT.ind(EP-1) & TypeAG=AGN)	$none()	Stopped
W.EndS	Phy_ALARM.ind	DL_ALARM.ind()	Stopped
W.EndS	Phy_ABORT.ind(ErrorNb) & ErrorNb<>EP-1 & ErrorNb<>EP-2	DL_ABORT.ind(ErrorNb)	W.EndS
T.Req	exist_dl_req(DL_IB.req())	Fr="" Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, IB, Fr) Fr=concat(Fr, crc(Fr)) Phy_UNACK.req(Fr)	W.EndS
T.Req	exist_dl_req(DL_Discover.req(DSDU)) & TypeAG=AGN	MaxRSO=3 NbRSO=1 ListRSO="" Collision=FALSE Fr=DSDU Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, ASO, Fr) Fr=concat(Fr, crc(Fr)) Phy_ASO.req(Fr)	M.RSO
T.Req	exist_dl_req(DL_Discover.req(DSDU)) & TypeAG=AGT	MaxRSO=1 NbRSO=1 ListRSO="" Collision=FALSE Fr=DSDU Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, ASO, Fr) Fr=concat(Fr, crc(Fr)) Phy_ASO.req(Fr)	M.RSO
T.Req	not (exist_dl_req(DL_IB.req()) | exist_dl_req(DL_ Discover.req(_)))	Pr=0 Send="00"B Confirm="11"B Fr="" Index=Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec

État initial	Conditions de déclenchement	Ensemble d'actions	État final
T.Req	exist_dl_req(DL_XBR.req(proposed_baudrate)	Fr="proposed_baudrate" Index=Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, XBR, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	M.Rec
M.RSO	Phy_ASO.ind(Frame) & size(Frame)=0	$none()	*T.RSO*
M.RSO	Phy_ASO.ind(Frame) & check_frame(Frame) & command(Frame)=RSO	build_RSO(ListRSO, Frame)	*T.RSO*
M.RSO	Phy_ASO.ind(Frame) & not(check_frame(Frame)) & size(Frame)<>0	Collision=TRUE	*T.RSO*
M.RSO	Phy_COLL.ind()	Collision=TRUE	*T.RSO*
M.RSO	DL_ABORT.req(_)	Phy_ABORT.req()	W.EndS
M.RSO	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	W.EndS
T.RSO	MaxRSO=1 & Collision	MaxRSO=3 Collision=FALSE RepeatASO=TRUE Phy_APPG.req(AGN)	W.AG
T.RSO	(MaxRSO=1 & not(Collision)) | (MaxRSO<>1 & NbRSO>=MaxRSO)	DL_Discover.ind (Collision, ListRSO)	W.EndS
T.RSO	NbRSO<MaxRSO	NbRSO=NbRSO+1	M.RSO
M.Send	exist_dl_data_req(DL_DATA.req(Pr=1, Service class DSDU)) & ((& not(TreqTimout))) NbChain < MaxChain	Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index= Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) Stop_timer(Treq)	M.Rec
M.Send	not(DL_DATA.req(Pr=1, _)) & exist_dl_data_req(DL_DATA.req(Pr=0, Service class DSDU)) & ((& not(TreqTimout))) NbChain < MaxChain	Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index= Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) Stop_timer(Treq)	M.Rec
M.Send	not(DL_DATA.req(_, _)) & TreqTimeout()& NbChain < MaxChain	Pr=0 Fr="" Index= Index + 1 NbChain = NbChain + IncrChain Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) initTimer(Treq)	M.Rec
M.Send	NbChain >= MaxChain	Phy_APPG.req(AGN)	W.AG

État initial	Conditions de déclenchement	Ensemble d'actions	État final
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & is_text(Frame)	DL_DATA.ind(extract_prty(Frame), extract_text(Frame)) Confirm=incr(Confirm) Ack_expected=FALSE Index = 0 initTimer(Treq)	*M.Send*
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & not(is_text(Frame))	Ack_expected=FALSE Index = 0 initTimer(Treq)	*M.Send*
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & Index<=MaxRetry	Phy_DATA.req(Fr) Index=Index+1	M.Rec
M.Rec	Phy_DATA.ind(Frame) & not(check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & Index>MaxRetry	DL_ABORT.ind(EL-2F) Phy_ABORT.req()	W.EndS
M.Rec	DL_ABORT.req(Strong=0) & not(DL_DATA.req(_, _)) & Ack_expected=FALSE	Phy_ABORT.req()	W.EndS
M.Rec	DL_ABORT.req(Strong=1)	Phy_ABORT.req()	W.EndS
M.Rec	Phy_ABORT.ind(ErrorNb)	DL_ABORT.ind(ErrorNb)	W.EndS
M.Rec	Phy_DATA.ind(Frame) & (check_frame(Frame) & (check_address(Frame) & (Com =XBA)	DL_ChangeBaudrate.ind(accepted_baudrate).	M.Rec
M.Rec	exist_dl_physical_setup_req(params)	Phy_SETUP(params) wait(TES)	T.Req

Tableau 38 – Transitions d'état de *DLMS/COSEM Link-E/D*: Station secondaire

État initial	Conditions de déclenchement	Ensemble d'actions	État final
Initial	*$true()*	MaxRetry=2 FlagDSO=TRUE Discovered=FALSE Flag_alarm=FALSE	Stopped
Stopped	*Phy_DATA.ind(Frame) & check_frame(Frame) & check_address(Frame)*	ADP=extract_ADP(Frame) Com=command(Frame)	*T.Com*
Stopped	*Phy_DATA.ind(Frame) & check_frame(Frame) & not(check_address(Frame))*	Phy_ABORT.req()	Stopped
Stopped	*Phy_DATA.ind(Frame) & not(check_frame(Frame))*	$none()	Stopped
Stopped	*DL_Alarm.req()*	Phy_ABORT.req() Flag_alarm = TRUE Phy_ALARM.req()	Stopped
T.Com	*Com=IB*	Discovered=FALSE DL_IB.ind() Phy_ABORT.req()	Stopped
T.Com	*Com=ASO & test_TABi(Frame, TAB)*	DL_Discover.ind(TAB)	W.MM
T.Com	*Com=XBR*	DL_ChangeBaudrate.ind(proposed_baudrate)	W.MM

État initial	Conditions de déclenchement	Ensemble d'actions	État final
T.Com	*is_data+(Frame) & is_text(Frame)*	Ack_expected=FALSE Send="11"B Confirm="00"B DL_DATA.ind(extract_prty, extract_text(Frame)) initTimer(Treq)	*M.Send*
T.Com	*is_data+(Frame) & not(is_text(Frame))*	Ack_expected=FALSE Send="11"B Confirm="00"B initTimer(Treq)	*M.Send*
W.MM	*exist_dl_discover_req(TAB)*	Fr=concat(RSO, TAB, ADS) Fr=concat(size_frame(Fr), ADS, ADP, Fr) Fr=concat(Fr, crc(Fr)) Phy_RSO.req(Fr, window_RSO())	*stopped*
W.MM	*exist_dl_discover_req(not(TAB))*	Phy_ABORT.req()	*stopped*
W.MM	*exist_dl_change_baud_rate.req(acceptedBaudrate)*	Discovered = TRUE Fr= acceptedBaudrate Index=1 Size=size_frame(Fr) Fr=concat(Size, ADS, ADP, XBA, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr)	*M.Rec*
M.Send	*exist_dl_data_req(DL_DATA.req(Pr=1, DSDU)) & not(Treqtimeout())*	Discovered = TRUE Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index=1 Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) Stop_timer(Treq)	M.Rec
M.Send	*not(DL_DATA.req(Pr=1, _)) & exist_dl_data_req(DL_DATA.req(Pr=0, DSDU)) & not(Treqtimeout())*	Discovered = TRUE Send=incr(Send) Ack_expected=TRUE Fr=DSDU Index=1 Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) Stop_timer(Treq)	M.Rec
M.Send	*not(DL_DATA.req(_, _))& TreqTimeout()*	Pr=0 Fr="" Index=1 Size=size_frame(Fr) Com=com(DATA+,Pr,Send,Confirm) Fr=concat(Size, ADS, ADP, Com, Fr) Fr=concat(Fr, crc(Fr)) Phy_DATA.req(Fr) initTimer(Treq)	M.Rec
M.Rec	*Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & is_text(Frame)*	Confirm=incr(Confirm) Ack_expected=FALSE DL_DATA.ind(extract_prty, extract_text(Frame)) initTimer(Treq)	*M.Send*
M.Rec	*Phy_DATA.ind(Frame) & (check_frame(Frame) & check_address(Frame) & is_data+(Frame) & is_ack(Frame)) & not(is_text(Frame))*	Ack_expected=FALSE initTimer(Treq)	*M.Send*

État initial	Conditions de déclenchement	Ensemble d'actions	État final
M.Rec	*Phy_DATA.ind(Frame) & not(check_frame(Frame) &* *check_address(Frame) &* *is_data+(Frame) &* *is_ack(Frame)) &* *Index<=MaxRetry*	Phy_DATA.req(Fr) Index=Index+1	M.Rec
M.Rec	*Phy_DATA.ind(Frame) & not(check_frame(Frame) &* *check_address(Frame) &* *is_data+(Frame) &* *is_ack(Frame)) &* *Index>MaxRetry*	DL_ABORT.ind(EL-2F) Phy_ABORT.req()	Stopped
M.Rec	*DL_ABORT.req(Strong=0) & not(DL_DATA.req(_, _)) & Ack_expected=FALSE*	Phy_ABORT.req()	Stopped
M.Rec	*DL_ALARM.req() &* *alarm_detection()*	DL_ABORT.ind(EL_1F) Phy_ABORT.req() Flag_alarm = TRUE Phy_ALARM.req()	Stopped
M.Rec	*DL_ABORT.req(Strong=1)*	stop_timer(T1) Phy_ABORT.req()	Stopped
M.Rec	*Phy_ABORT.ind(EP-1)*	DL_ABORT.ind(EL_3F)	M.Rec
M.Rec	*Phy_ABORT.ind(ErrorNb) &* *ErrorNb <> EP-1*	DL_ABORT.ind(ErrorNb)	Stopped
M.Rec	*exist_dl_physical_setup_req()*	Phy_SETUP(params)	M.Rec

Tableau 39 – Signification des états mentionnés dans les tableaux précédents

État	Signification
Initial	Initialisation des variables de la couche
Stopped	État d'attente de la première demande de la couche supérieure ou de la première indication de la couche inférieure
W.AG (Wait for end of "Wake-up Calll")	Attente de la fin de l'émission d'un signal "Appel général"
W.EndS (Wait for end of Session)	État d'attente de la fin d'une session
T.Req (Test Request)	Vérification de la nature d'une requête provenant de la couche supérieure
M.RSO (Must Receive RSO)	État d'attente des réponses à un Appel des Stations Oubliées
T.RSO (Test last RSO)	Vérification de la fin du dernier intervalle de temps pour la réception d'une trame RSO
M.Send (Must Send)	Essai de la trame à envoyer (le champ Text peut être vide)
M.Rec (Must Receive)	État initial du récepteur, attente du premier octet d'une trame
T.Com (Test Command)	Vérification du champ COM d'une trame reçue
W.MM (Wait for Support Manager event)	État d'attente de réception d'un événement de la couche gestion du support.

Tableau 40 – Définition des procédures et des fonctions classées par ordre alphabétique

Procédure ou fonction	Définition
alarm_detection()	Vérification que le mode Alarme est Actif
build_RSO(ListRSO, Frame)	Extraction des éléments (champs TAB et ADS) de la trame RSO reçue Frame et concaténation avec la précédente liste ListRSO
check_address(Frame)	Vérification que les adresses ADP et ADS sont reconnues selon les critères suivants: • la station est sensibilisée à l'ADP ou ADP = APG; • ADS=ADG si le code de commande est ASO, IB ou TRB, • ADS est l'adresse de la station secondaire si le code de commande n'est pas ASO, IB ou TRB
check_frame(Frame)	Vérification que la trame Frame reçue est correcte: • nombre d'octets supérieur ou égal à 11 et inférieur ou égal à MaxIndex; • CRC correct; • nombre d'octets compatible avec le champ Size; • code de commande connu et nombre d'octets compatible avec ce code de commande
com(DATA+, Pr, Send, Confirm)	Concaténation des champs binaires correspondants pour obtenir une commande spécifique
command(Frame)	Extraction de la valeur du code de commande d'une trame Frame reçue
concat(Size, ADS, ADP, COM, Text), Ou concat(Frame, CRC)	Concaténation des champs Size, ADS, ADP, COM et Text ou concaténation du CRC à la fin de la trame Frame
context(ADS, ADP, TypeAG)	Extraction des valeurs correspondantes du contexte de communication
crc(Frame)	Calcul du CRC de la trame Frame à émettre
create_alarm(TPDU)	Calcul d'un TPDU avec STSAP = 0, DTSAP = 0 et un UnsolicitedReqPDU avec: client-type = FFFF, serveridentifier = 0 , object-name = FFFF variable type = boolean, value = TRUE
exist_dl_data-req(DL_DATA.req(Pr, DSDU))	Consommation d'un événement DL_DATA.req(Pr, DSDU)
exist_dl_req()	Vérification de l'existence d'un événement DL_IB.req(), DL_ASO.req(DSDU) ou DL_DATA.req(Pr, DSDU) et vérification de la compatibilité avec les adresses ADS et ADP du contexte de communication
exist_dl_req(DL_IB.req()) or exist_dl_req(DL_ASO.req(DSDU))	Consommation d'un événement DL_IB.req ou DL_ASO.req(DSDU)
exist_dl_physical_setup_req	Consommation d'un événement de reconfiguration du baudrate
extract_ADP(Frame)	Si la valeur d'ADP utilisée dans la trame est différente de APG ou bien s'il s'agit de APG mais que la liste des valeurs ADP auxquelles est sensibilisée la Station Secondaire est vide, extraction de cette valeur, sinon extraction de la première valeur ADP à laquelle est sensibilisée la Station Secondaire
extract_prty(Frame)	Extraction du champ Priority de la trame Frame reçue
extract_text(Frame)	Extraction du champ Text de la trame Frame reçue
init(TypeAG)	Met Index à MaxRetry si TypeAG vaut AGT, à 0 sinon
init_incrChain()	Met IncrChain à 0 si les alarmes ne sont pas prises en charge, à 1 sinon
init_timer(T1)	Armement du temps de réveil T1
initTimer(Req)	Initialisation du temporisateur d'attente d'une requête venant des couches supérieures
is_ack (Frame)	Vérification que la trame Frame reçue contient un champ Confirm égal au champ Send de la dernière trame émise
is_data+ (Frame)	Vérification que la trame Frame reçue contient un champ DATA+ correct ("111" B)

Procédure ou fonction	Définition
is_text(Frame)	Vérification que la trame Frame reçue contient un champ de données Text non vide et que le champ Send est égal au complément à un du champ Confirm de la dernière trame émise.
size(Frame)	Calcul de la taille de la trame Frame reçue
size_frame(DSDU)	Calcul de la taille de la trame à construire à partir de l'unité de données DSDU (taille de DSDU+11)
stop_timer(T1)	Désarmement du temps de réveil T1
test_TABi(Frame, TAB)	Si le premier TABi contenu dans la trame ASO Frame vaut 00, vérification que la variable Discovered est à FAUX et vérification, après tirage d'un nombre aléatoire entre 0 et 100, que ce nombre entier est inférieur à la probabilité de réponse souhaitée au deuxième des TABi. Dans ce cas, la valeur 00 est mémorisée dans la variable TAB. Si le premier TABi contenu dans la trame ASO Frame reçue vaut FF, vérification que la variable Flag_alarm est à VRAI et dans ce cas affectation de la valeur FAUX à la variable Flag_alarm et mémorisation de la valeur FF dans la variable TAB. Si le premier TABi contenu dans la trame ASO Frame reçue ne vaut ni 00 ni FF, vérification que la variable FlagDSO est à VRAI, que la Station Secondaire est sensibilisée à l'un des TABi contenus dans la trame Frame de type ASO reçue. Dans ce cas, mémorisation de la première de ces valeurs dans la variable TAB
time_out(T1)	Armement du temps de réveil T1
TreqTimeout()	Vérification que le temps d'attente d'une requête venant des couches supérieures n'excède pas un temps t tel que la durée du temps d'expiration TOL géré par la couche physique peut arriver à terme. Ce temps d'attente est nécessairement inférieur à TOL et est armé dès que l'indication est envoyée à la couche supérieure.
window_RSO()	Fourniture d'une valeur aléatoire entière comprise entre 0 et MaxRSO-1 utilisée comme numéro de l'intervalle de temps RSO au cours duquel la station doit répondre (voir l'Annexe F)

7.4 Couche Gestion du support

7.4.1 Généralités

La couche Gestion du Support traite tous les services relatifs aux activités liées au support de communication. Ces services sont les suivants:

- l'initialisation du bus;
- la gestion des découvertes;
- la gestion des alarmes;
- la négociation de la vitesse.

Ces services sont gérés de façon à être cohérents avec leur gestion sous les profils avec ou sans DLMS. Pour ces services, les identifiants ont les valeurs indiquées dans le Tableau 41:

Tableau 41 – Commandes gérées par la Gestion du Support

Identifiant	Valeur hexa	Rôle	P/S
ASO	07	Requête de découverte	Station Primaire
RSO	08	Réponse à la Requête de découverte	Station secondaire
IB	09	Initialisation du bus	Station Primaire
XBR	0x12	Requête de changement de vitesse (baudrate)	Station Primaire
XBA	0x13	Réponse à la Requête de changement de vitesse	Station secondaire

7.4.2 Initialisation du bus

Elle est gérée conformément à 4.4.6. Bien que l'initialisation soit gérée par la couche gestion du support, son traitement est entièrement assuré par la couche liaison de données.

7.4.3 Service Discover

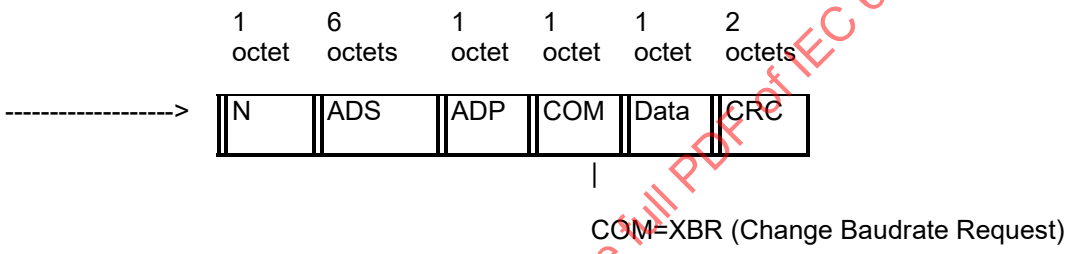
Le service Discover est géré conformément à 4.4.7 et à l'Annexe H. Le champ TAB contient deux paramètres d'un octet chacun: le premier paramètre a la valeur 0, valeur à laquelle tous les équipements sont sensibilisés. Le second est la probabilité de réponse.

7.4.4 Négociation de la vitesse

Après établissement de la connexion au niveau Liaison de données, les couches de gestion du support peuvent négocier la vitesse de communication. Cette négociation est toujours réalisée à l'initiative du dispositif primaire.

Les vitesses autorisées sont 1 200, 2 400, 4 800 et 9 600 bauds.

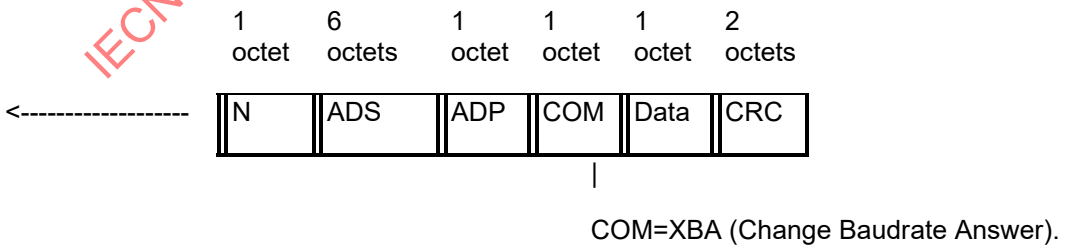
- Trame de négociation de la vitesse de communication



Le champ Data contient la vitesse à laquelle l'équipement primaire (client) désire poursuivre la communication. Leurs valeurs sont les suivantes:

- 0x00 1 200 bauds,
- 0x01 2 400 bauds,
- 0x02 4 800 bauds,
- 0x03 9 600 bauds.

- La trame de réponse de la station secondaire est la suivante:



Le champ Data contient la vitesse sélectionnée par la station secondaire.

Un retard TES de 50 ms est observé par la station primaire à la fin du processus, ceci afin de permettre aux deux stations en présence de régler les dispositifs connectés sur la vitesse sélectionnée.

Après un changement de vitesse concluant, les paramètres suivants sont modifiés comme cela est indiqué dans le Tableau 42:

Tableau 42 – Liste des paramètres

Paramètre	Valeur initiale	Valeur après négociation
Baudrate	1 200 baud	Valeur négociée
MaxIndex	128	255
TOL	100 ms	1 000 ms
TA10	160 ms	1 100 ms

7.4.5 Paramètres de Gestion du support

Pour une station Primaire, la valeur du nombre maximal d'intervalles de temps RSO pour le traitement d'une trame "discover" est fixée à 3.

7.4.6 Transitions d'état

Les transitions d'état de Gestion du support layer sont indiquées dans le Tableau 43, le Tableau 44, le Tableau 45 et le Tableau 46.

Tableau 43 – Transition d'état de la couche Gestion du support: Station Primaire

État initial	Conditions de déclenchement	Ensemble d'actions	État final
Stopped	Exist_req(discover)	TABi=0 DL_Discover.req()	M.Rec
Stopped	Exist_req(change_baud_rate)	Baudrate = proposed_baudrate DL_ChangeBaudrate.req()	M.Rec
Stopped	DL_abort.ind(ErrorNb)	T Abort.ind() Update(FatalError)	Stopped
Stopped	Exist_req(init_bus)	DL_InitBus_req()	Stopped
Stopped	Exist_req(abort)	DL_Abort.req()	Stopped
Stopped	DL_alarm.ind()	MM alarm.ind()	Stopped
M.Rec	Exist_cnf(discover)	MM discover.cnf(disc list)	Stopped
M.Rec	Exist_cnf(change_baud_rate) & check(proposed_baudrate)	Baud_rate = accepted_baudrate DL_PhysicalSetup.req(accepted_baudrate)	Stopped
M.Rec	Exist_cnf(change_baud_rate) not(check(received_baudrate))	$none	Stopped