DIN EN IEC 62056-3-1

ICS 33.200; 35.110; 35.240.99; 91.140.50

Ersatz für
DIN EN 62056-3-1
(VDE 0418-6-3-1):2014-12
Siehe Anwendungsbeginn

Datenkommunikation der elektrischen Energiemessung – DLMS/COSEM – Teil 3-1: Nutzung lokaler Netzwerke mit Trägerfrequenz-Signalübertragung auf verdrillten Zweidrahtleitungen (IEC 62056-3-1:2021); Englische Fassung EN IEC 62056-3-1:2021

Electricity metering data exchange –
The DLMS/COSEM suite –
Part 3-1: Use of local area networks on twisted pair with carrier signalling
(IEC 62056-3-1:2021);
English version EN IEC 62056-3-1:2021

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
(IEC 62056-3-1:2021);
Version anglaise EN IEC 62056-3-1:2021

Gesamtumfang 132 Seiten

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE

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Anwendungsbeginn

Anwendungsbeginn für die von CENELEC am 2021-08-11 angenommene Europäische Norm als DIN-Norm ist 2023-05-01.

Für DIN EN 62056-3-1 (VDE 0418-6-3-1):2014-12 besteht eine Übergangsfrist bis 2024-08-11.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN EN IEC 62056-3-1 (VDE 0418-6-3-1):2019-05.

Für dieses Dokument ist das nationale Arbeitsgremium DKE/K 461 „Messeinrichtungen und -systeme für Elektrizität“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE (www.dke.de) zuständig.

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Da sich die Benutzer der vorliegenden Norm der englischen Sprache als Fachsprache bedienen, wird die Englische Fassung der EN IEC 62056-3-1 veröffentlicht. Zu deren Einleitung, Abschnitt 1, der den Anwendungsbereich festlegt und Abschnitt 3, der die Begriffe festlegt, wurde eine Übersetzung angefertigt und als informativer Nationaler Anhang NA der vorliegenden Norm hinzugefügt. Für die meisten der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

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Änderungen

Gegenüber DIN EN 62056-3-1 (VDE 0418-6-3-1):2014-12 wurden folgende Änderungen vorgenommen:

a) Ergänzung eines Profils, das die DLMS/COSEM-Anwendungsschicht und das COSEM-Objektmodell nach IEC 62056 nutzt;

b) Überprüfung der Sicherungsschicht, die in zwei Teile unterteilt wird:
   – eine reine Sicherungsschicht;
   – eine „Support Manager“-Instanz, die die Kommunikationsmedien verwaltet;

c) Fähigkeit der Vereinbarung der Kommunikationsgeschwindigkeit, die Baudraten bis 9 600 Baud bewirken kann.

Frühere Ausgaben

DIN EN 61142: 1994-07
DIN EN 62056-31 (VDE 0418-6-31): 2000-10
DIN EN 62056-3-1 (VDE 0418-6-3-1): 2014-12

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Nationaler Anhang NA
(informativ)

Auszugsweise Übersetzung

Reihenfolge und Inhalt der folgenden Abschnitte sind identisch mit denen in den jeweiligen Abschnitten der Englischen Fassung.

1 Anwendungsbereich

Dieser Teil der IEC 62056 beschreibt zwei Profilsätze: Der erste Profilsatz erlaubt eine bidirektionale Kommunikation zwischen einem Client und einem Server. Dieser Profilesatz besteht aus drei Profilen, die einen Datenaustausch über den lokalen Bus mit Stationen zulassen, die entweder gespeist oder nichtgespeist sind. Für nichtgespeiste Stationen stellt der Bus die Energie zur Verfügung, die zum Datenaustausch benötigt wird. Es werden drei verschiedene Profile unterstützt:

– Basisprofil: Dieses dreischichtige Profil stellt Fernkommunikationsdienste bereit.

  ANMERKUNG 1 Dieses erste Profil wurde in IEC 61142:1993 veröffentlicht und wurde als Euridis-Norm bekannt.

– Profil mit DLMS: Dieses Profil lässt die Nutzung von DLMS-Diensten nach den Festlegungen in IEC 61334-4-41 zu.

  ANMERKUNG 2 Dieses zweite Profil wurde in IEC 62056-31:1999, veröffentlicht.

– Profil mit DLMS/COSEM: Dieses Profil erlaubt die Nutzung der DLMS/COSEM-Anwendungsschicht und des COSEM-Objektmodells nach den Festlegungen in IEC 62056-5-3 bzw. in IEC 62056-6-2.

Die drei Profile nutzen dieselbe Bitübertragungsschicht und sie sind vollständig kompatibel, was bedeutet, dass Geräte, die eins dieser Profile implementieren, am selben Bus betrieben werden können. Das Übertragungsmedium ist eine verdrillte Zweidrahtleitung mit Trägerfrequenz-Signalübertragung und wird als Euridis-Bus bezeichnet.

Der zweite Profilsatz erlaubt eine unidirektionale Kommunikation zwischen einem vorgegebenen Energiemessgerät und einem Kunden-Energiemanagementsystem. Dieser zweite Satz besteht aus drei Profilen.

In Unterabschnitt 4.2.1 bis einschließlich Abschnitt 8 wird die bidirektionale Kommunikation mit Signalübertragung auf verdrillten Zweidrahtleitungen beschrieben und in Abschnitt 9 bis 9.5 die unidirektionale Kommunikation mit Signalübertragung auf verdrillten Zweidrahtleitungen.

3 Begriffe und Abkürzungen

3.1 Begriffe

In diesem Dokument werden keine Begriffe aufgeführt.

ISO und IEC stellen terminologische Datenbanken für die Verwendung in der Normung unter den folgenden Adressen bereit:

– IEC Electropedia: verfügbar unter http://www.electropedia.org/

– ISO Online Browsing Platform: verfügbar unter http://www.iso.org/obp

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3.2 Abkürzungen

Abkürzung	Bedeutung	
ADP	primäre Stationsadresse	(en: Primary Station Address)
ADG	allgemeine Sekundadresse	(en: General Secondary Address, Broadcast Address)
ADS	sekundäre Stationsadresse	(en: Secondary Station Address)
AGN	normale Betriebsbereitschaft	(en: Normal Wakeup)
AGT	allgemeiner Aufruf für eine allgemeine gespeiste Station	(en: General call for a General Energized Station)
APDU	Protokolldateneinheit der Anwendungsschicht	(en: Application Protocol Data Unit)
APG	allgemeine Primäradresse	(en: General Primary Address)
ARJ	COM-Feldwert: Zurückweisung der Authentifizierung beim Fernprogrammierungs-Datenaustausch	(en: Rejection of authentication in remote programming exchange)
ASDU	Dienstdateneinheit der Anwendungsschicht	(en: Application Service Data Unit)
ASO	COM-Feldwert: Aufruf der vergessenen Stationen	(en: Call to Forgotten Stations)
AUT	COM-Feldwert: Authentifizierungsbefehl	(en: Authentication command)
COM	Gruppenbegriffsfeld der Sicherungsschicht	(en: Control field of the Data Link layer)
COSEM	Begleitspezifikation für die Energiemessung	(en: Companion Specification for Energy Metering)
DAT	COM-Feldwert: Antwort einer Fernauslesung	(en: Response of remote reading exchange)
DES	Datenverschlüsselungsnorm	(en: Data Encryption Standard)
DLMS	Spezifikation für Verteilungsleitungsnachrichten (IEC 61334-4-41) Spezifikation für Gerätesprachennachrichten (IEC 62056-5-3)	(en: Distribution Line Message Specification) (en: Device Language Message Specification)
DSDU	Dienstdateneinheit der Datenverbindung	(en: Data link Service Data Unit)
DRJ	COM-Feldwert: Daten zurückgewiesen COM-Wert, der die Zurückweisung des Fernprogrammierungs-Datenaustauschs anzeigt	(en: Data Rejected)
Dsap	Etikett der Transportdateneinheit, codiert mit 3 bit, der Wert ist 6	(en: Transport data unit label)
DTSAP	Ziel des Transportdienst-Zugangspunkts	(en: Destination of Transport Service Access Point)
ECH	COM-Feldwert: Echo eines Fernprogrammierungs-Datenaustauschs	(en: Echo of remote programming exchange data)
ENQ	Anforderung der Zählerstandsfernauslesung	(en: Remote reading exchange request)
EOS	COM-Feldwert: Ende der Fernprogrammierungs-Datenaustauschs	(en: End of remote programming exchange)
IB	Businitialisierung	(en: Initialisation of the bus)
LDTI	lokale Datenübertragungsschnittstelle	(en: Local Data Transmission Interface)
MaxRetry	größte Anzahl der Übertragungswiederholungen, auf 2 begrenzt	(en: Maximum number retransmissions)
MaxRSO	größte Anzahl von Fenstern, die RSO auflisten, mit 3 festgelegt	(en: Maximum number of RSO listening windows)
PDU	Protokolldateneinheit	(en: Protocol Data Unit)
PRE	COM-Feldwert: Vorauswahl von gespeisten Stationen	(en: Pre-selection of energised stations)
REC	COM-Feldwert: Anforderung eines Fernprogrammierungs-Datenaustauschs	(en: Remote programming exchange request)
RSO	COM-Feldwert: Antwort auf einen „Aufruf der vergessenen Stationen“	(en: Response to a call to forgotten stations)

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Abkürzung	Bedeutung	
SEL	COM-Feldwert: Auswahlquittung der gespeisten Stationen	(en: Acknowledgement of the pre-selection of energized stations)
STSAP	Quelladresse des Transportdienst-Zugangspunkts	(en: Source Transport Service Access Point)
TAB	im Falle von EURIDIS-Profilen ohne DLMS und ohne DLMS/COSEM: Datencode im Falle von Profilen mit DLMS oder DLMS/COSEM: Wert, mit dem das Gerät für „Discovery“ programmiert ist	
TABi	Liste des TAB-Feldes	
TASB	Dauer eines Alarmsignals auf dem Bus	(en: Duration of an Alarm Signal on the Bus)
TIC	Informationsübertragung zum Kunden	(en: Transmission of Information to the Customer)
TOAG	maximale Wartezeit für eine bereits ausgewählte gespeiste Station bis zur Erkennung eines allgemeinen Aufrufs zum AGN	
TOALR	Warten vor dem Senden eines AGN nach dem Empfang von AGN oder AGT	
TOL	maximale Wartezeit einer Anforderung, die aus der übergeordneten Schicht kommt	
TOPRE	maximale Wartezeit für eine Antwort auf eine Vorauswahl	
TOU	Zeitpunkt der Nutzung	(en: Time of Use)
TPDU	Transportprotokolldateneinheit	(en: Transport Protocol Data Unit)
TSDU	Transportprotokolldiensteinheit	(en: Transport Protocol Service Unit)
TRA	COM-Feldwert: Punkt-zu-Punkt-Übertragungsquittung	(en: Acknowledgement of point to point transfer)
TRB	COM-Feldwert: Datenübertragungsblock einer Sammelaufruf-Fernübertragung, nicht quittiert	(en: Broadcast remote transfer frame not acknowledged)
TRF	COM-Feldwert: Punkt-zu-Punkt-Fernübertragung	(en: Point to point remote transfer exchange)
T1	Zeitablauf zum Warten auf eine Antwort auf eine Anforderung	
XBA	COM-Feldwert: Antwort auf eine Anforderung zur Änderung der Geschwindigkeit	(en: Response to a change of speed request)
XBR	COM-Feldwert: Anforderung zur Änderung der Geschwindigkeit	(en: Change of speed request)
ZA1	reserviertes Feld für eine bidirektionale Authentifizierung der Programmierung	
ZA2	reserviertes Feld für eine bidirektionale Authentifizierung der Programmierung	

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EUROPEAN STANDARD

NORME EUROPÉENE

EUROPÄISCHE NORM

EN IEC 62056-3-1

August 2021

ICS 17.220.20; 35.110; 91.140.50

Supersedes EN 62056-3-1:2014 and all of its amendments and corrigenda (if any)

English version

Electricity metering data exchange – The DLMS/COSEM suite – Part 3-1: Use of local area networks on twisted pair with carrier signalling (IEC 62056-3-1:2021)

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 (IEC 62056-3-1:2021)

Datenkommunikation der elektrischen Energiemessung – DLMS/COSEM – Teil 3-1: Nutzung lokaler Netzwerke mit Trägerfrequenz-Signalübertragung auf verdrillten Zweidrahtleitungen (IEC 62056-3-1:2021)

This European Standard was approved by CENELEC on 2021-08-11. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Europäisches Komitee für Elektrotechnische Normung

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European foreword

The text of document 13/1794/CDV, future edition 2 of IEC 62056-3-1, prepared by IEC/TC 13 “Electrical energy measurement and control” was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62056-3-1:2021.

The following dates are fixed:

– latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop): 2022-05-11

– latest date by which the national standards conflicting with the document have to be withdrawn (dow): 2024-08-11

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Endorsement notice

The text of the International Standard IEC 62056-3-1:2021 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 62056-6-1:2017 NOTE Harmonized as EN 62056-6-1:2017 (not modified).

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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 61334-4-41	1996	Distribution automation using distribution line carrier systems – Part 4: Data communication protocols – Section 41: Application protocol – Distribution line message specification	EN 61334-4-41	1996
IEC 62056-5-3	2017	Electricity metering data exchange – The DLMS/COSEM suite – Part 5-3: DLMS/COSEM application layer	EN 62056-5-3	2017
IEC 62056-6-2	2017	Electricity metering data exchange – The DLMS/COSEM suite – Part 6-2: COSEM interface classes	EN IEC 62056-6-2	2018
IEC 62056-51	1998	Electricity metering – Data exchange for meter reading, tariff and load control – Part 51: Application layer protocols	–	–
ISO/IEC 8482	1993	Information technology – Telecommunications and information exchange between systems – Twisted pair multipoint interconnections	–	–
EIA 485	–	Electrical characteristics of generators and receivers for use in balanced digital multipoint systems	–	–

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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

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*

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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

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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.

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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.

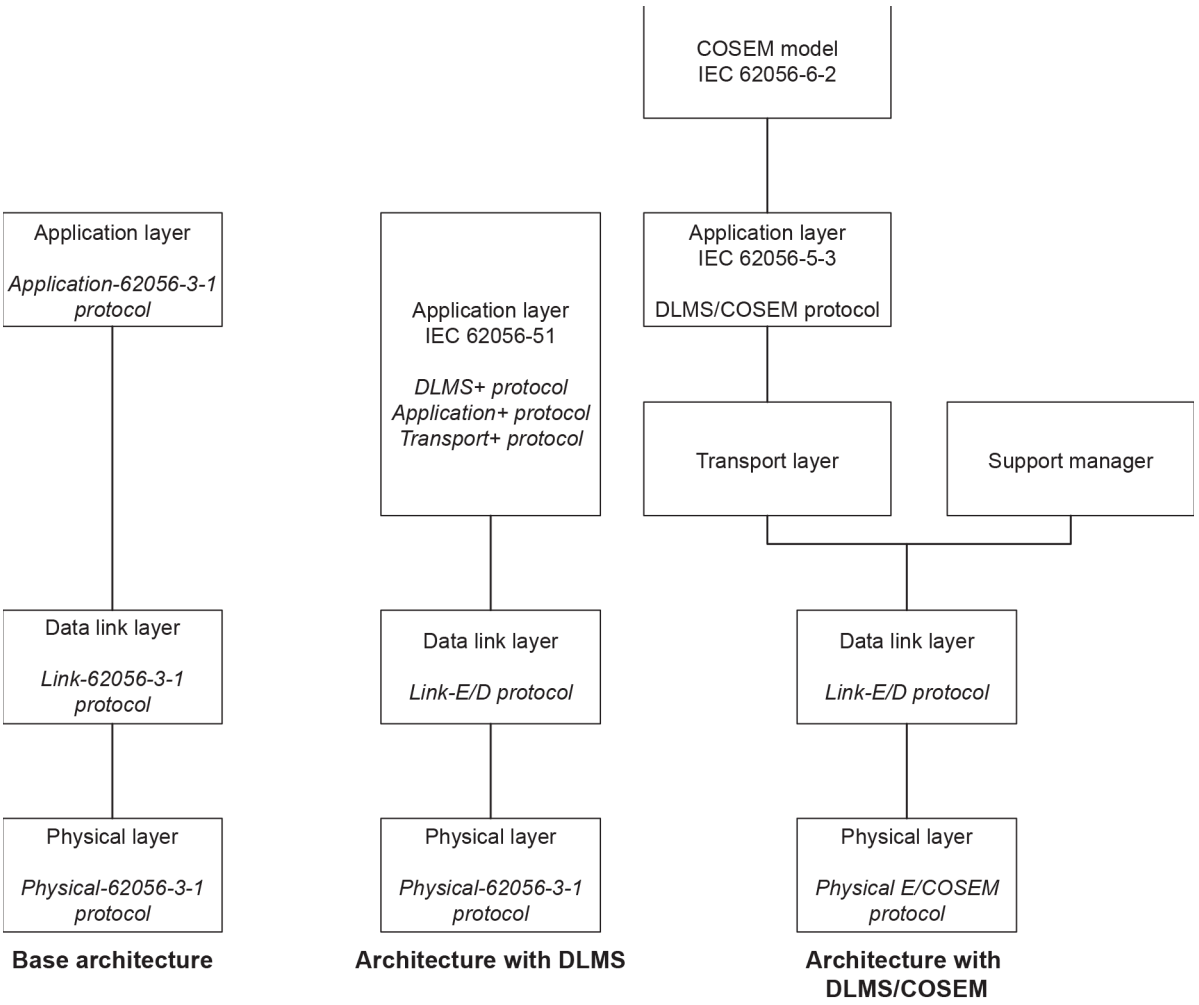

Figure 1 – IEC 62056-3-1 communication profiles

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.

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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.

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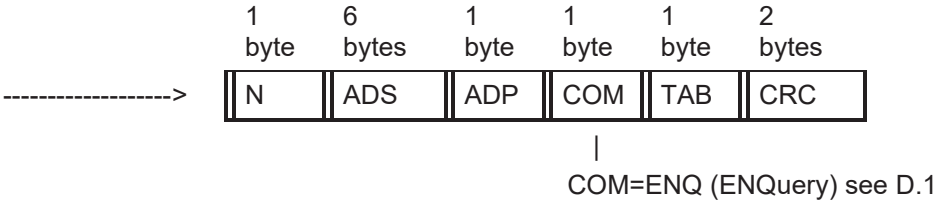
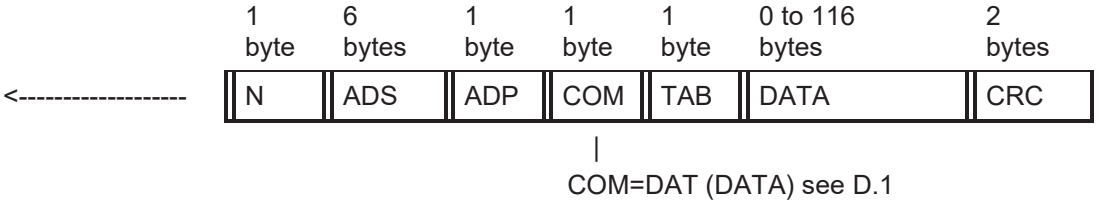
4.4.2 Remote reading exchange

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

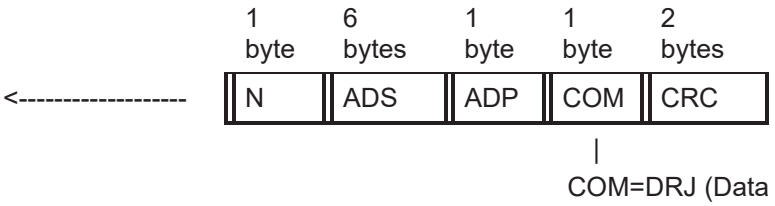
- remote reading frame containing the type of data to select in the TAB field



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



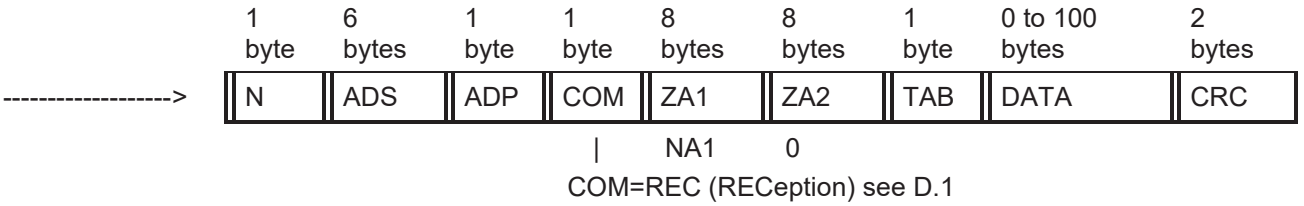
- negative acknowledgement frame (TAB identifier unknown)



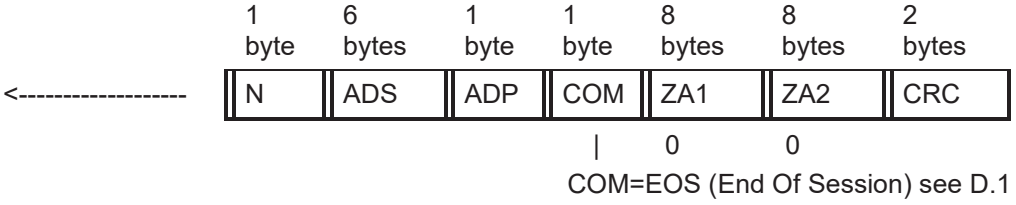
4.4.3 Remote programming exchange

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)



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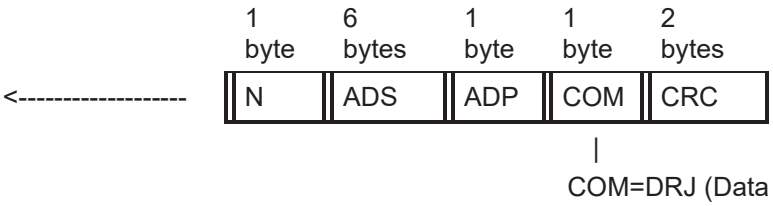
- negative acknowledgement frame (no authentication trouble but remote programming data not validated)



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.

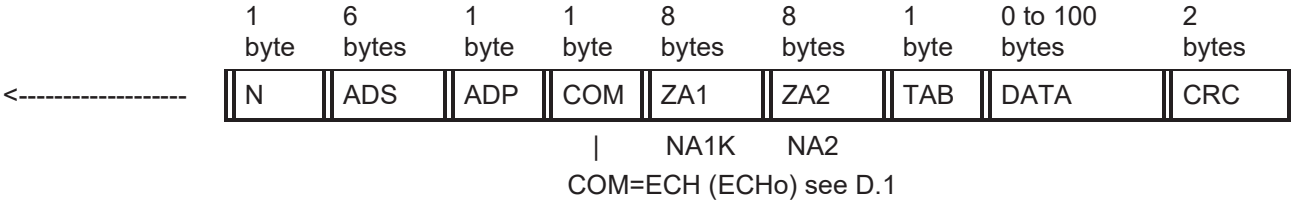
On reception of this frame, the Primary Station compares the ZA1 field to an NA1´ number obtained by ciphering the transmitted NA1 number using the DES algorithm with key Ki. If NA1´ = ZA1, then the Primary Station considers the called Secondary Station as authenticated. Otherwise, it considers the Secondary 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.

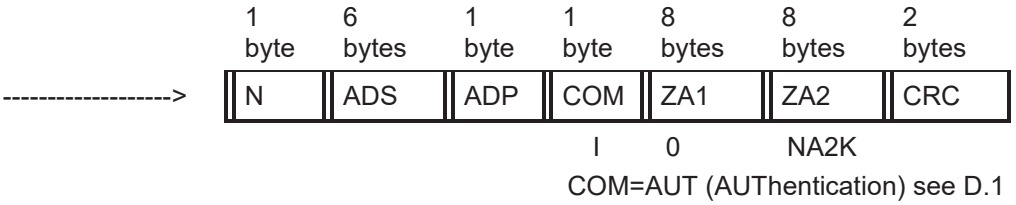
On reception of this response frame, the Secondary Station compares the ZA2 field to an NA2´ number obtained by ciphering the transmitted NA2 number using the DES algorithm with key Ki. If NA2´ = ZA2, then the Secondary Station considers the Primary Station as authenticated. Otherwise, it considers the 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)



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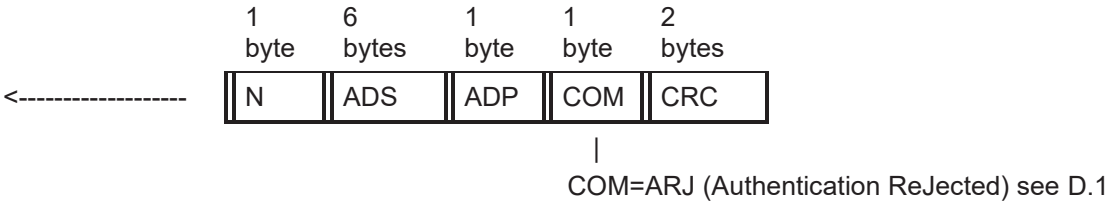
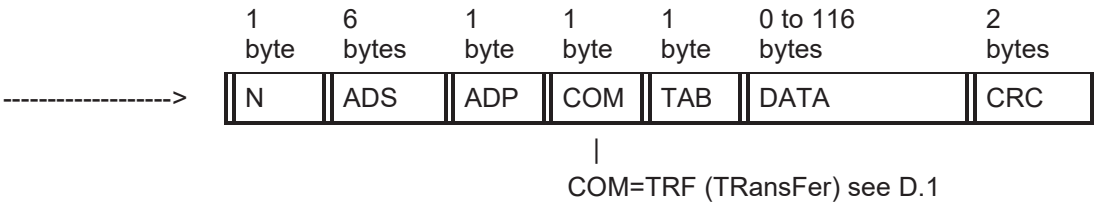
- an authentication rejection frame replaces the normal EOS or DRJ frame when the Primary Station is not considered authenticated



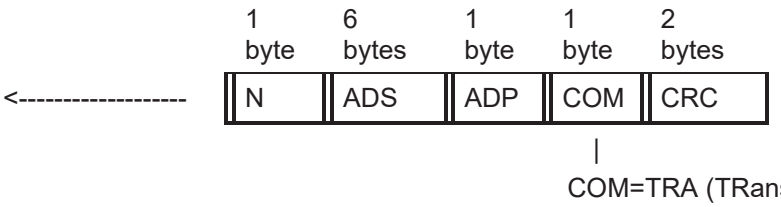
4.4.4 Point to point remote transfer exchange

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:

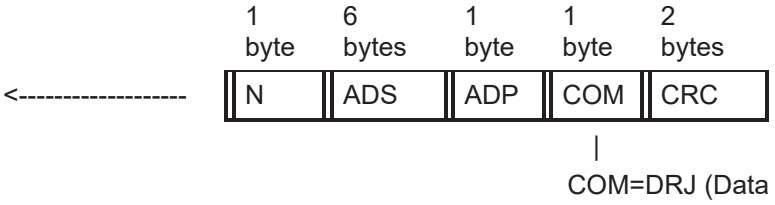
- point to point remote transfer frame containing data in the DATA field and their type in the TAB field



- positive acknowledgement frame



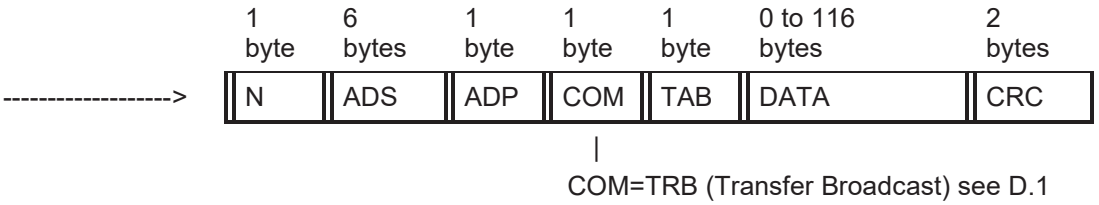
- negative acknowledgement frame (remote transfer data not validated)



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.

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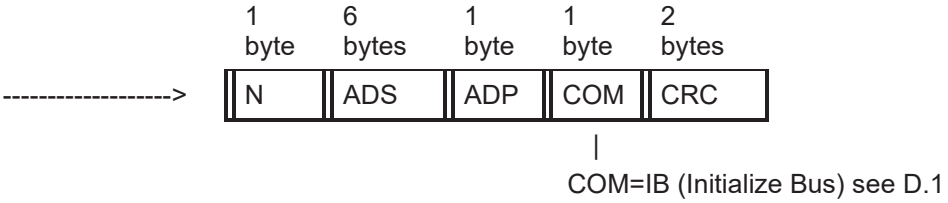
4.4.6 Bus initialization frame

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

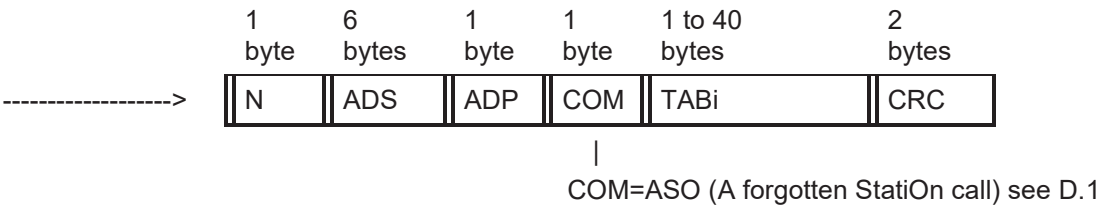
This ASO exchange consists of two frames arranged in one sequence. At the end of a remote reading sequence, the Primary Station can search for stations whose forgotten station flag is TRUE (maximum 5 in 100).

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.

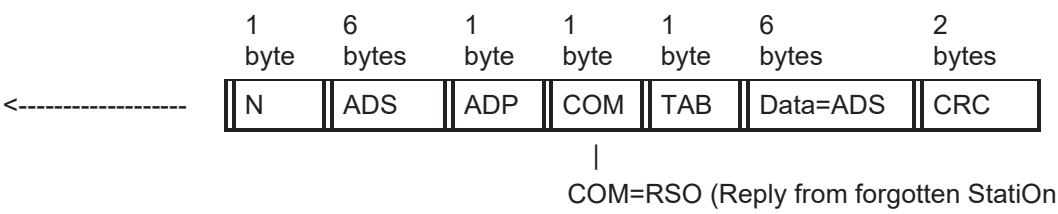
In order to ensure the selection constraints (described in 4.4.9), the non-energized stations shall answer in the first time slot of the first ASO exchange. Then, only the forgotten stations are selected and the usual principle can be used for the following ASO exchanges.

- 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.

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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).

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;

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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.

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- 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.

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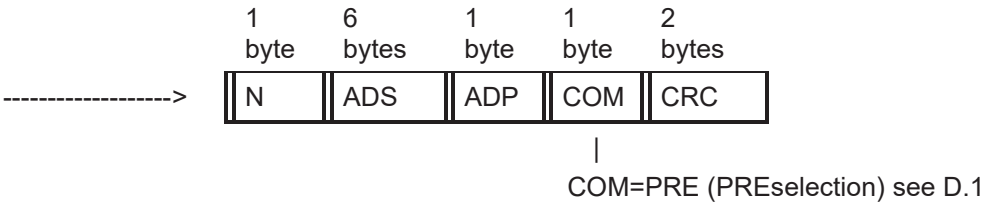
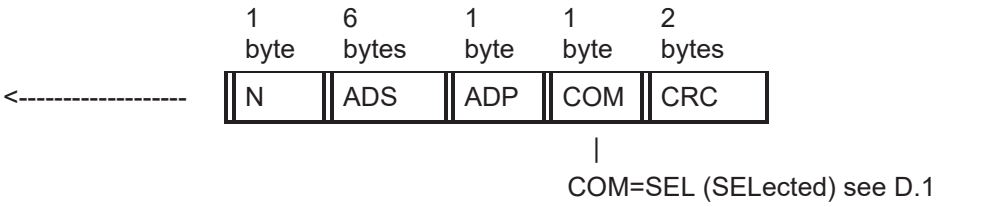
- non-energized station preselection frame



- 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.

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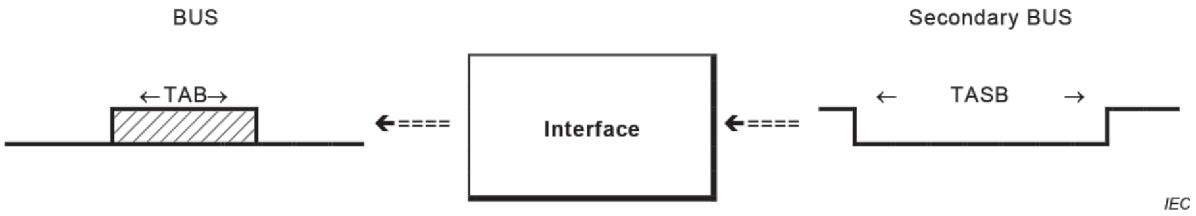

Figure 2 – Alarm mechanism

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

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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.

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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.

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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.

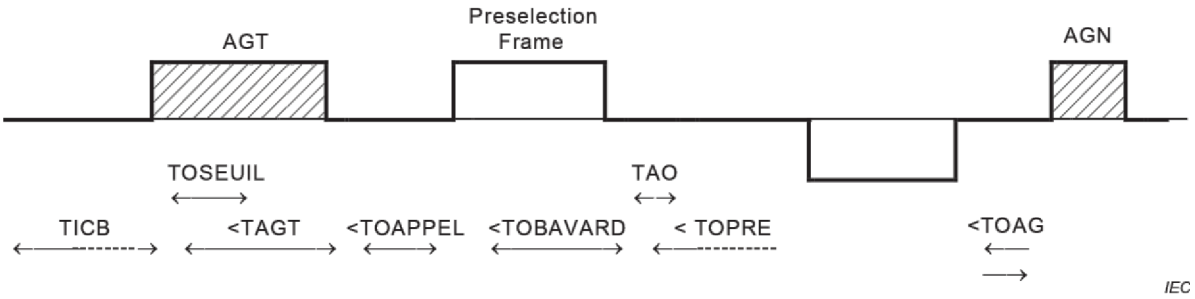

Figure 3 – Exchanges in continuous operation

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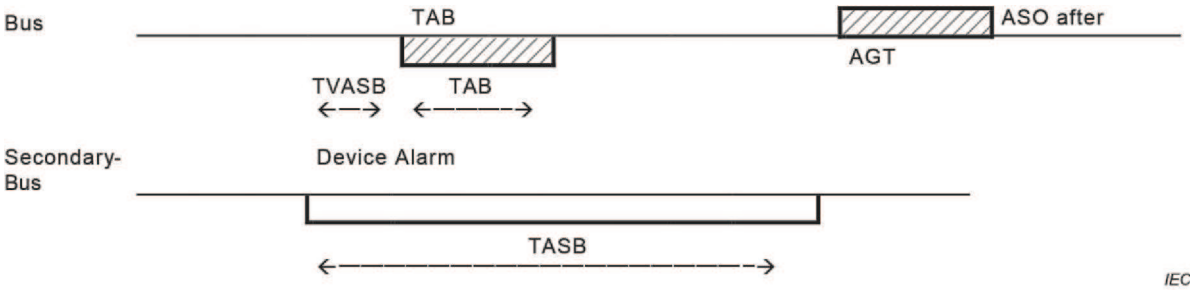

Figure 4 – Alarm event without any communication in progress

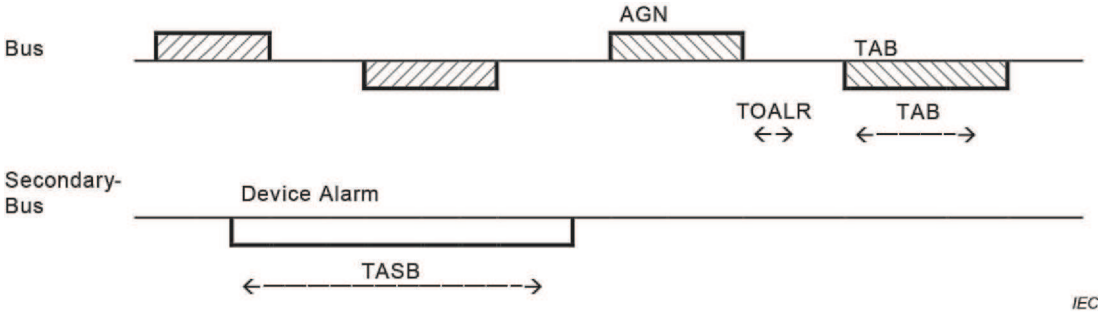

Figure 5 – Alarm event with a communication in progress

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;

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- 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
W.AG	Phy_ABORT.req()	FlagAbort=TRUE	W.AG
W.TAB	data-carrier_on	Carrier = TRUEinit_timer(TAB) init_timer (TASB)	W.TAB

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Initial state	Triggering condition	Set of actions	Final state
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

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Initial state	Triggering condition	Set of actions	Final state
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
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

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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

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Initial state	Triggering condition	Set of actions	Final state
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)	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*

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Initial state	Triggering condition	Set of actions	Final state
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
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

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State	Meaning
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 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

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