



BSI Standards Publication

Industrial communication networks – Fieldbus specifications

Part 6-25: Application layer protocol specification –
Type 25 elements (IEC 61158-6-25:2019)

National foreword

This British Standard is the UK implementation of EN IEC 61158-6-25:2019. It is identical to IEC 61158-6-25:2019.

The UK participation in its preparation was entrusted to Technical Committee GEL/65/3, Industrial communications: process measurement and control, including fieldbus.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Amendments/corrigenda issued since publication

Date	Text affected
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English Version

**Industrial communication networks - Fieldbus specifications -
Part 6-25: Application layer protocol specification - Type 25
elements
(IEC 61158-6-25:2019)**

Réseaux de communication industriels - Spécifications des
bus de terrain - Partie 6-25: Spécification du protocole de la
couche application - Eléments de type 25
(IEC 61158-6-25:2019)

Industrielle Kommunikationsnetze - Feldbusse - Teil 6-25:
Protokollspezifikation des Application Layer
(Anwendungsschicht) - Typ 25-Elemente
(IEC 61158-6-25:2019)

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Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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European foreword

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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) 2020-04-25
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-07-25

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Endorsement notice

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

IEC 61158-1	NOTE	Harmonized as EN IEC 61158-1
-------------	------	------------------------------

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.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61158-3-25	2019	Industrial communication networks - Fieldbus specifications - Part 3-25: Data-link layer service definition - Type X elements	EN IEC 61158-3-25	2019
IEC 61158-5-25	2019	Industrial communication networks - Fieldbus specifications - Part 5-25: Application layer service definition - Type 25 elements	EN IEC 61158-5-25	2019
ISO/IEC 7498-1	-	Information technology - Open Systems Interconnection - Basic reference model: The basic model		-
ISO/IEC 8822	-	Information technology - Open Systems Interconnection - Presentation service definition		-
ISO/IEC 9545	-	Information technology - Open Systems Interconnection - Application layer structure		-
ISO/IEC 8824-1	-	Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation		-
ISO/IEC/IEEE 8802-3	-	Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 3: Standard for Ethernet		-
IEEE 802.1D	-	IEEE Standard for local and metropolitan area networks - Media Access Control (MAC) Bridges		-
IEEE 802.1Q	-	IEEE Standard for Local and metropolitan area networks - Media Access Control (MAC) Bridges and Virtual Bridges		-
IETF RFC 768	-	User Datagram Protocol		-
IETF RFC 791	-	Internet Protocol - DARPA Internet Program Protocol Specification		-

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CONTENTS

FOREWORD.....	7
INTRODUCTION.....	9
1 Scope.....	10
1.1 General.....	10
1.2 Specification	11
1.3 Conformance	11
2 Normative references	11
3 Terms, definitions, symbols, abbreviations and conventions	12
3.1 Reference model terms and definitions	12
3.1.1 ISO/IEC 7498-1 terms.....	12
3.1.2 ISO/IEC 8822 terms.....	12
3.1.3 ISO/IEC 9545 terms.....	12
3.1.4 ISO/IEC 8824-1 terms.....	13
3.2 Additional Type 25 terms and definitions.....	13
3.3 Symbols and abbreviations	15
3.4 Conventions.....	16
3.4.1 General conventions.....	16
3.4.2 Conventions for class definitions	16
3.4.3 Conventions for bit description in octets	16
3.4.4 Conventions for state machine descriptions	17
4 FAL syntax description	18
4.1 FAL PDU type S abstract syntax	18
4.1.1 Basic abstract syntax.....	18
4.2 FAL PDU type N abstract syntax	22
4.2.1 Basic abstract syntax.....	22
4.2.2 CyclicData-PDU.....	22
4.2.3 MulticastData-PDU	23
4.2.4 PtoPData-PDU.....	23
4.2.5 Aliveinfo-PDU	23
4.2.6 Aliveinfo6-PDU	23
4.2.7 Inq-PDU	24
4.2.8 Ninq-PDU	24
4.2.9 Reply-PDU	24
4.2.10 RetransEnq-PDU	24
4.2.11 RetransConfirm-PDU	24
4.2.12 RetransNak-PDU	25
4.3 Data type assignments for type S.....	25
4.4 Data type assignments for type N	25
5 FAL transfer syntax	26
5.1 Encoding rules.....	26
5.1.1 Unsigned encoding	26
5.1.2 Octet string encoding.....	27
5.1.3 SEQUENCE encoding.....	27
5.2 FALPDU type S elements encoding.....	27
5.2.1 RCL_header	27
5.2.2 RHE-PDU	28

5.2.3	LCC-PDU	30
5.2.4	LCA-PDU	30
5.2.5	LCN-PDU	31
5.2.6	LNA-PDU	32
5.2.7	SCR-PDU	32
5.2.8	Cyclic_S-PDU	32
5.2.9	Cyclic_header	33
5.2.10	Control-PDU	33
5.2.11	RMTCTL-PDU	33
5.2.12	INFO-PDU	34
5.3	FALPDU type N elements encoding	35
5.3.1	General	35
5.3.2	FALAR-N Header	35
5.3.3	CyclicData-PDU	49
5.3.4	MulticastData-PDU	50
5.3.5	PtoP Data-PDU	50
5.3.6	Aliveinfo-PDU	50
5.3.7	Aliveinfo6-PDU	53
5.3.8	Inq-PDU	54
5.3.9	Ninq-PDU	55
5.3.10	Reply-PDU	55
5.3.11	RetransEnq-PDU	56
5.3.12	RetransConfirm-PDU	56
5.3.13	RetransNak-PDU	57
6	Structure of the FAL protocol state machine	58
7	FAL service protocol machine (FSPM)	58
7.1	Overview	58
7.2	FSPM type S	58
7.2.1	Overview	58
7.2.2	Interface of cyclic communication to FAL users	59
7.2.3	State machine of FSPM	61
7.3	FSPM type N	62
7.3.1	Overview	62
7.3.2	FSPM	63
8	Application relationship protocol machine (ARPM)	65
8.1	ARPM type S	65
8.1.1	Overview	65
8.1.2	Cyclic control	66
8.1.3	Remote control	70
8.1.4	RCL communication control	75
8.1.5	RT communication control	79
8.2	ARPM type N	83
8.2.1	Overview	83
8.2.2	General control	83
8.2.3	Cyclic transmission control	85
8.2.4	Acyclic transmission control	90
8.2.5	RT communication control	105
9	DLL mapping protocol machine (DMPM)	121

9.1	DMPM type S.....	121
9.2	DMPM type N.....	122
9.2.1	General	122
9.2.2	Communication port in transport layer	122
9.2.3	Quality of Service	122
	Bibliography.....	124
	Figure 1 – Bit description in octets	16
	Figure 2 – hd_sa.....	35
	Figure 3 – hd_da.....	36
	Figure 4 – Valid sequence number for reception message	40
	Figure 5 – hd_m_ctl	40
	Figure 6 – Valid reception packet sequence number	44
	Figure 7 – Node-list	55
	Figure 8 – Relationships between protocol machines	58
	Figure 9 – Structure of FSPM type S.....	59
	Figure 10 – Shared memory allocation in type S network	61
	Figure 11 – Structure of FSPM type N.....	63
	Figure 12 – Structure of ARPM type S	66
	Figure 13 – Sequence of cyclic communication.....	67
	Figure 14 – The primitives for cyclic control	67
	Figure 15 – The primitives for Remote control.....	70
	Figure 16 – The primitives for RCL communication control.....	75
	Figure 17 – The primitives for RT communication control	80
	Figure 18 – Structure of ARPM type N	83
	Figure 19 – Primitives of Cyclic transmission control.....	85
	Figure 20 – Primitives of acyclic transmission control	91
	Figure 21 – DSCP format.....	123
	Figure 22 – IEEE 802.1Q tag frame format	123
	Table 1 – State transition descriptions	17
	Table 2 – Descriptions of state machine elements	17
	Table 3 – Conventions used in state machine	17
	Table 4 – Frame Class.....	27
	Table 5 – DA_STaddress – DA_STaddress.....	27
	Table 6 – DA_MACaddress.....	27
	Table 7 – CMD field format	28
	Table 8 – Send Direction	28
	Table 9 – RHE ReceiveStatus.....	29
	Table 10 – Physical Linkdown.....	29
	Table 11 – RHE_pattern 1~4.....	30
	Table 12 – LCC-Kind	30
	Table 13 – RCL Status.....	31
	Table 14 – hd_h_type	31

Table 15 – Usage of Mgn or Lnn	37
Table 16 – Detailed conditions for sequence number check of reception message	39
Table 17 – Valid bits of hd_m_ctl	40
Table 18 – Specified TCD	41
Table 19 – hd_pkind	42
Table 20 – PDU with an effective hd_pseq	42
Table 21 – Detailed conditions for sequence number check of reception packet (Multicast communication with retransmission).....	44
Table 22 – Detailed conditions for packet sequence number check	45
Table 23 – Relation between message transmission/reception	46
Table 24 – hd_mode	46
Table 25 – Message priority level.....	46
Table 26 – Value of α	47
Table 27 – Example of header information for a UDP message fragmentation	47
Table 28 – Example of header information for a TCP message fragmentation	47
Table 29 – inqid_inq_sa value.....	48
Table 30 – inqid_tr_adr value.....	48
Table 31 – inqid_inq_seq value.....	49
Table 32 – Relationship between inqid_id_seq and inqid_tr_adr	49
Table 33 – Type of an alive-message.....	51
Table 34 – Type of an alive-message protocol	51
Table 35 – Time of each al_mode	52
Table 36 – Status change of tasks	52
Table 37 – Change of tasks content	52
Table 38 – The threshold of transmission factor	60
Table 39 – Example of the traffic control configuration menu	60
Table 40 – Cyclic data state table	61
Table 41 – Acyclic data state table.....	62
Table 42 – Cyclic data state table	64
Table 43 – Acyclic data state table.....	64
Table 44 – Cyclic control state table	68
Table 45 – Cyclic control functions.....	69
Table 46 – Cyclic control variables.....	70
Table 47 – Remote control state table.....	71
Table 48 – Remote control functions	74
Table 49 – Remote control variables	75
Table 50 – RCL communication control state table.....	76
Table 51 – RCL communication control functions	77
Table 52 – RCL communication control variables	79
Table 53 – RT communication control state table	80
Table 54 – RT communication control functions	82
Table 55 – RT communication control variables	82
Table 56 – Cyclic transmission control state table	86

Table 57 – Cyclic transmission control functions	88
Table 58 – Cyclic transmission control variables	90
Table 59 – Acyclic transmission control state table	91
Table 60 – Acyclic transmission control functions	101
Table 61 – Acyclic transmission control variables	104
Table 62 – RT communication control state table	105
Table 63 – RT communication control functions	116
Table 64 – RT communication control variables	120
Table 65 – ARPM to DL mapping	122
Table 66 – Assignment policy of communication ports	122
Table 67 – Default DSCP, IEEE 802.1D and IEEE 802.1Q priority mapping	123

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
FIELDBUS SPECIFICATIONS –****Part 6-25: Application layer protocol specification –
Type 25 elements****FOREWORD**

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International Standard IEC 61158-6-25 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

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

FDIS	Report on voting
65C/948/FDIS	65C/956/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61158 series, published under the general title *Industrial communication networks – Fieldbus specifications*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

A bilingual version of this publication may be issued at a later date.

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.

INTRODUCTION

This document is one of a series produced to facilitate the interconnection of automation system components. It is related to other standards in the set as defined by the “three-layer” fieldbus reference model described in IEC 61158-1.

The application protocol provides the application service by making use of the services available from the data-link or other immediately lower layer. The primary aim of this document is to provide a set of rules for communication expressed in terms of the procedures to be carried out by peer application entities (AEs) at the time of communication. These rules for communication are intended to provide a sound basis for development in order to serve a variety of purposes:

- as a guide for implementers and designers;
- for use in the testing and procurement of equipment;
- as part of an agreement for the admittance of systems into the open systems environment;
- as a refinement to the understanding of time-critical communications within OSI.

This document is concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices. By using this document together with other standards positioned within the OSI or fieldbus reference models, otherwise incompatible systems may work together in any combination.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-25: Application layer protocol specification – Type 25 elements

1 Scope

1.1 General

The Fieldbus Application Layer (FAL) provides user programs with a means to access the fieldbus communication environment. In this respect, the FAL can be viewed as a “window between corresponding application programs.”

This International Standard provides common elements for basic time-critical and non-time-critical messaging communications between application programs in an automation environment and material specific to Type 25 fieldbus. The term “time-critical” is used to represent the presence of a time-window, within which one or more specified actions are required to be completed with some defined level of certainty. Failure to complete specified actions within the time window risks failure of the applications requesting the actions, with attendant risk to equipment, plant and possibly human life.

This document defines in an abstract way the externally visible behavior provided by the different Types of the fieldbus Application Layer in terms of:

- a) the abstract syntax defining the application layer protocol data units conveyed between communicating application entities,
- b) the transfer syntax defining the application layer protocol data units conveyed between communicating application entities,
- c) the application context state machine defining the application service behavior visible between communicating application entities; and
- d) the application relationship state machines defining the communication behavior visible between communicating application entities.

The purpose of this document is to define the protocol provided to:

- a) define the wire-representation of the service primitives defined in IEC 61158-5-25, and
- b) define the externally visible behavior associated with their transfer.

This document specifies the protocol of the IEC fieldbus Application Layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498-1) and the OSI Application Layer Structure (ISO/IEC 9545).

FAL services and protocols are provided by FAL application-entities (AE) contained within the application processes. The FAL AE is composed of a set of object-oriented Application Service Elements (ASEs) and a Layer Management Entity (LME) that manages the AE. The ASEs provide communication services that operate on a set of related application process object (APO) classes. One of the FAL ASEs is a management ASE that provides a common set of services for the management of the instances of FAL classes.

Although these services specify, from the perspective of applications, how request and responses are issued and delivered, they do not include a specification of what the requesting and responding applications are to do with them. That is, the behavioral aspects of the applications are not specified; only a definition of what requests and responses they can

send/receive is specified. This permits greater flexibility to the FAL users in standardizing such object behavior. In addition to these services, some supporting services are also defined in this document to provide access to the FAL to control certain aspects of its operation.

1.2 Specification

The principal objective of this document is to specify the syntax and behavior of the application layer protocol that conveys the application layer services defined in IEC 61158-5-25. A secondary objective is to provide migration paths from previously-existing industrial communications protocols. It is this latter objective which gives rise to the diversity of protocols standardized in subparts of IEC 61158-6.

1.3 Conformance

This document does not specify individual implementations or products, nor does it constrain the implementations of application layer entities within industrial automation systems.

There is no conformance of equipment to the application layer service definition standard. Instead, conformance is achieved through implementation of this application layer protocol specification.

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.

NOTE All parts of the IEC 61158 series, as well as IEC 61784-1 and IEC 61784-2 are maintained simultaneously. Cross-references to these documents within the text therefore refer to the editions as dated in this list of normative references.

IEC 61158-3-25:2019, *Industrial communication networks – Fieldbus specifications – Part 3-25: Data-link layer service definition – Type 25 elements*

IEC 61158-5-25:2019, *Industrial communication networks – Fieldbus specifications – Part 5-25: Application layer service definition – Type 25 elements*

ISO/IEC 7498-1, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

ISO/IEC 8822, *Information technology – Open Systems Interconnection – Presentation service definition*

ISO/IEC 9545, *Information technology – Open Systems Interconnection – Application Layer structure*

ISO/IEC 8824-1, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*

ISO/IEC/IEEE 8802-3, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet*

IEEE Std 802.1D, *IEEE Standard for Local and metropolitan area networks – Media access Control (MAC) Bridges*; available at <http://www.ieee.org> [viewed 2018-09-17]

IEEE Std 802.1Q, *IEEE Standard for Local and metropolitan area networks – Bridges and Bridged Networks*; available at <http://www.ieee.org> [viewed 2018-09-17]

IETF RFC 768, *User Datagram Protocol*; available at <http://www.ietf.org> [viewed 2018-09-17]

IETF RFC 791, *Internet Protocol*; available at <http://www.ietf.org> [viewed 2018-09-17]

3 Terms, definitions, symbols, abbreviations and conventions

For the purposes of this document, the following terms, definitions, symbols, abbreviations and conventions apply.

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>

3.1 Reference model terms and definitions

3.1.1 ISO/IEC 7498-1 terms

For the purposes of this document, the following terms given in ISO/IEC 7498-1 apply:

application entity;
 application process;
 application protocol data unit;
 application service element;
 application entity invocation;
 application process invocation;
 application transaction;
 real open system;
 transfer syntax.

3.1.2 ISO/IEC 8822 terms

For the purposes of this document, the following terms given in ISO/IEC 8822 apply:

a) abstract syntax;
 presentation context.

3.1.3 ISO/IEC 9545 terms

For the purposes of this document, the following terms given in ISO/IEC 9545 apply:

a) application-association;
 application-context;
 application context name;
 application-entity-invocation;
 application-entity-type;
 application-process-invocation;
 application-process-type;
 application-service-element;

application control service element.

3.1.4 ISO/IEC 8824-1 terms

For the purposes of this document, the following terms given in ISO/IEC 8824-1 apply:

a) object identifier;
type.

3.2 Additional Type 25 terms and definitions

For the purpose of this document, the following definitions also apply.

NOTE Many definitions are common to more than one protocol Type; they are not necessarily used by all protocol Types.

3.2.1

ADP message

message conveyed by an autonomous decentralized system protocol

3.2.2

alive-message

message reporting own node state, periodically transmitted

3.2.3

block

basic unit of data transferred in a cyclic communication, each having a size of 64 octets

3.2.4

category N_f

category of an autonomous decentralized system protocol (full specifications) in type N

3.2.5

category N_l

category of an autonomous decentralized system protocol (light weight specifications) in type N

3.2.6

control communication

acyclic data communication for higher time-critical applications in type S network

3.2.7

cyclic communication

periodic data communication for real-time communication

3.2.8

cyclic transfer memory

memory which is allocated to each node in the data field, which each node transmits periodically for the purpose of sharing of this memory area logically

3.2.9

data field

logical place through which specific data passes, corresponding to real networks

3.2.10

domain

administrative set consisting of multiple data fields

3.2.11

duplex LAN

two different network-paths between end nodes

3.2.12

equipment

physical hardware connected to the network

EXAMPLE Station, device, and server.

3.2.13

information communication

acyclic data communication for lower time-critical application in type S network

3.2.14

logical node, node

equipment in data fields, where an autonomous decentralized system's function is installed

3.2.15

message mode

identifier that indicates the uses of a message (whether an online message or a test message)

EXAMPLE Online message or a test message.

3.2.16

multicast group

group of nodes belonging to a data field to determine whether to receive same data from other node

3.2.17

node list

bit array structure of specifying a node to receive a request data

3.2.18

node mode

identifier that indicates the usage of a node

EXAMPLE Online node or a test node.

3.2.19

primary local area network

local area network (LAN) used in normal state in a duplex LAN system

3.2.20

priority control

transmission order control for the packets arrived from networks, according to the virtual local area network (VLAN)

3.2.21

ring control communication

control for the type S ring network using ring control (RCL) frames

3.2.22

remote control

control for other nodes connected to a network

3.2.23

secondary local area network

local area network (LAN) for backup of a primary LAN in a duplex LAN system

3.2.24**transaction code**

information to identify the characteristics of the message within a PDU

3.3 Symbols and abbreviations

ADP	Autonomous Decentralized Protocol
ADS-net	Autonomous Decentralized System – network
AE	Application Entity
AL	Application Layer
AP	Application Process
APDU	Application Protocol Data Unit
APO	Application Process Object
AR	Application Relationship
AREP	Application Relationship Endpoint
ARPM	Application Relationship Protocol Machine
ASCII	American Standard Code for Information Interchange
ASE	Application Service Element
ASN.1	Abstract Syntax Notation 1
CRC	Cyclic Redundancy Check
DF	Data Field
Dfn	Data Field Number
DLL	Data-link Layer
Dmn	DoMain Number
DMPM	DLL Mapping Protocol Machine
DSCP	DiffServ Code Point
FAL	Fieldbus Application Layer
FSPM	FAL Service Protocol Machine
GMT	Greenwich Mean Time
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
LAN	Local area network
LCA	Loop condition alert (Type S frame type)
LCC	Loop condition check (Type S frame type)
LCN	Loop condition notify (Type S frame type)
LLD	Logical link down
LLU	Logical link up
LNA	Loop notify answer (Type S frame type)
Lnn	Logical Node Number
LSB	Least Significant Bit
MCG	MultiCast Group
Mgn	Multicast Group Number
MSB	Most Significant Bit
MTU	Maximum Transmission Unit

OSI	Open Systems Interconnection
PDU	Protocol Data Unit
PLD	Physical link down
QoS	Quality-of-service
RCL	Ring control
RHE	Rapid hello (Type S frame type)
RMTCTL	Remote control
RT	Real time
SCR	Station condition report (Type S frame type)
TCD	Transaction CoDe
TCP	Transmission Control Protocol
TMID	Transfer Memory Identifier
UDP	User Datagram protocol

3.4 Conventions

3.4.1 General conventions

Conventions given in IEC 61158-3-25 are also applied in this document.

3.4.2 Conventions for class definitions

This description of FAL Type 25 uses a subset of ASN.1. The following structures are used.
Selective type (CHOICE) – Represents a selection from candidate types.

Sequence type (SEQUENCE) – Represents a fixed-order list as in the following example:

```
DLPDU ::= SEQUENCE {
  preamble    Preamble,
  sfd          SFD,
  destaddr    DestAddr,
  srcaddr     SrcAddr,
  vlantag     VLANtag,
  lt          LT,
  dlidu       FAL-PDU,
  fcs         FCS
}
```

NOTE This example shows that the DLPDU which represents the Ethernet frame is defined as SEQUENCE. The DLPDU consists of Preamble, SFD, DestAddr, SrcAddr, VLANtag, LT, FAL-PDU and FCS.

3.4.3 Conventions for bit description in octets

When identifying each bit in an octet, each bit is identified by a number as shown in Figure 1 and described as Bit n.

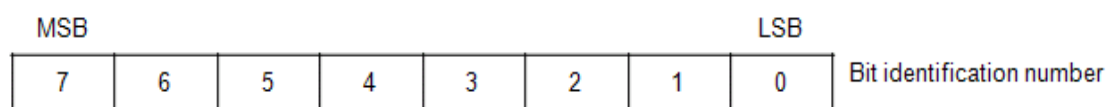


Figure 1 – Bit description in octets

When specifying multiple bits sequentially located, the range symbol (..) is used (e.g.: 7..0, specifies bits 7 through 0, inclusive).

When specifying multiple octets, the LSB of the lowest octet is assigned as 0, and bit identification numbers are assigned in an ascending order.

NOTE For example, when specifying 4 octets, the MSB of the highest octet is Bit 31, the MSB of the second octet is Bit 23, the MSB of the third octet is Bit 15, and the MSB of the lowest octet is Bit 7.

3.4.4 Conventions for state machine descriptions

The state machine description is defined in tabular form as shown in Table 1. The meanings of the elements are shown in Table 2. The conventions used in the state machines are shown in Table 3.

Each row of state table represents a state transition. The first column shows the state transition name or number. The second column shows the current state. The third column shows the events, conditions and actions. The fourth column shows the next state. When an event or condition is fulfilled, the action is performed and the state machine transits to the next state.

Table 1 – State transition descriptions

#	Current state	Event /condition => actions	Next state
---	---------------	-----------------------------------	------------

Table 2 – Descriptions of state machine elements

Description element	Meaning
#	Number of the transition
Current state, Next state	Names of the originating state and the target state of transition
Event	Name or description of the trigger event that fire the transition
/conditions	Boolean expression, which shall be true for the transition to be fired
=>actions	List of assignments and service or function invocations. The action should be atomic. The preceding “=>” is not part of the action
“*/ conditions” may be omitted.	

Table 3 – Conventions used in state machine

Convention	Meaning
=	Substitution of the right side for the left side
==	A logical condition to indicate an item on the left is equal to an item on the right.
!=	A logical condition to indicate an item on the left is not equal to an item on the right
<	A logical condition to indicate an item on the left is less than the item on the right
>	A logical condition to indicate an item on the left is greater than the item on the right
&&	Logical “AND”
	Logical “OR”
!	Negation operator
+ – * /	Arithmetic operator
;	Breakpoint
++	Increment operator
--	Decrement operator

4 FAL syntax description

4.1 FAL PDU type S abstract syntax

4.1.1 Basic abstract syntax

The definitions of FALPDU are shown below.

```
FAL-PDU ::= CHOICE {
    RCL-PDU,
    RT-PDU
}
```

```
RCL-PDU ::= CHOICE {
    RHE-PDU,
    LCC-PDU,
    LCA-PDU,
    LCN-PDU,
    LNA-PDU,
    SCR-PDU
}
```

```
RT-PDU ::= CHOICE {
    Cyclic_S-PDU,
    CTL-PDU,
    INFO-PDU
}
```

```
CTL-PDU ::= CHOICE {
    Control-PDU,
    RMTCTL-PDU
}
```

4.1.1.1 RCL-PDU

RCL_header to be used in each RCL-PDU is shown as follows.

```
RCL_header ::= SEQUENCE {
    Frame Class          CLASS,
    Dst Address          SEQUENCE {
        Reserved1        Unsigned8,
        DA_STaddress     ST_Address,
        DA_MACaddress    MAC_Address
    },
    Src Address          SEQUENCE {
        Reserved2        Unsigned8,
        SA_STaddress     ST_Address,
        SA_MACaddress    MAC_Address
    },
    RCL Command          RCLCMD,
    Frame Sequence       SequenceNum32,
    Reserved3            OCTET STRING(SIZE 20)
}
```

4.1.1.1.1 RHE-PDU

```

RHE-PDU ::= SEQUENCE {
    RCL_header      RCL_HEADER,
    RHE_header      SEQUENCE {
        RHE_Common  SEQUENCE {
            Send Direction      PortNum,
            RHE Sequence        SequenceNum32
        },
        Neighborhood address    SEQUENCE {
            Reserved1            Unsigned32,
            NB_STaddress         ST_Address,
            NB_MACaddress        MAC_Address
        },
        RHE ReceiveStatus       RHE_RxStatus,
        True Status              SEQUENCE {
            Reserved2            Unsigned32,
            Physical Linkdown    PLD,
            Reserved3            Unsigned32
        },
        Blocking Status          BLK_Status,
        Node Status              Node_Status,
        Reserved4                OCTET STRING(SIZE 20)
    },
    Reserved5                OCTET STRING(SIZE 64),
    RHE_pattern              SEQUENCE {
        RHE_pattern1           Pattern32,
        RHE_pattern2           Pattern32,
        RHE_pattern3           Pattern32,
        RHE_pattern4           Pattern32,
        .
        .
        .
    }
}

```

4.1.1.1.2 LCC-PDU

```

LCC-PDU ::= SEQUENCE {
    RCL_header      RCL_HEADER,
    LCC_header      SEQUENCE {
        LCC Kind      RCLKIND,
        LCC Priority    SEQUENCE {
            LCC_Priority    Priority,
            LCC_STadd       ST_Address,
            LCC_MACadd       MAC_Address
        },
        Reserved1          OCTET STRING(SIZE 52)
    }
}

```

4.1.1.1.3 LCA-PDU

```

LCA-PDU ::= SEQUENCE {
    RCL_header      RCL_HEADER,
    LCA_header      SEQUENCE {
        Reserved1            Unsigned32,
        RCL Status            RCL_Status,
        LCA Priority          SEQUENCE {
            LCA_Priority      Priority,
            LCA_STadd         ST_Address,
            LCA_MACadd         MAC_Address
        },
    },
}

```

```

        Reserved2          OCTET STRING(SIZE 48)
    }
}

```

4.1.1.1.4 LCN-PDU

```

LCN-PDU ::= SEQUENCE {
    RCL_header      RCL_HEADER,
    LCN_header      SEQUENCE {
        Reserved1      Unsigned32,
        RCL Status     RCL_Status,
        Reserved2      OCTET STRING(SIZE 56)
    }
}

```

4.1.1.1.5 LNA-PDU

```

LNA-PDU ::= SEQUENCE {
    RCL_header      RCL_HEADER,
    LNA_header      SEQUENCE {
        Reserved1      Unsigned32,
        RCL Status     RCL_Status,
        Reserved2      OCTET STRING(SIZE 56)
    }
}

```

4.1.1.1.6 SCR-PDU

```

SCR-PDU ::= SEQUENCE {
    RCL_header      RCL_HEADER,
    SCR_header      SEQUENCE {
        Entry Number  EntryNum,
        SendStat Time Send_Time,
        Reserved1     OCTET STRING(SIZE 52)
    },
    Event_info      SEQUENCE {
        Event0        EventData,
        Event1        EventData,
        .
        .
        .
        Event16       EventData
    }
}

```

4.1.1.2 RT-PDU

4.1.1.2.1 Cyclic_S-PDU

```

Cyclic_S-PDU ::= SEQUENCE {
    IP_header      IP_HEADER,
    UDP_header     UDP_HEADER,
    Reserved1      Unsigned16,
    Cyclic_header  CYCLIC_HEADER,
    Block_num      SEQUENCE {
        Block number1  BlockNum,
        Block number2  BlockNum,
        .
        .
        .
        Block number21 BlockNum,
        BBlock_num pattern Pattern16
    }
}

```

```

    },
    Cyclic_data      SEQUENCE {
        Block data1      BlockData,
        Block data2      BlockData,
        .
        .
        .
        Block data21     BlockData
    },
    Cyclic_FCS      CFCS
}

Cyclic_header ::= SEQUENCE {
    Cyclic_pattern    CYCLIC_PATTERN,
    Total_Block       TOTAL_BLOCK,
    Src STaddress     ST_Address,
    Reserved1         Unsigned8
}

```

4.1.1.2.2 CTL-PDU

4.1.1.2.2.1 Control-PDU,

```

Control-PDU ::= SEQUENCE {
    IP_header      IP_HEADER,
    UDP_header     UDP_HEADER,
    CTL_data       CTLdata
}

```

4.1.1.2.2.2 RMTCTL-PDU

```

CTL_cyclic-PDU ::= SEQUENCE {
    IP_header      IP_HEADER,
    UDP_header     UDP_HEADER,
    RMTCTL_CMD     SEQUENCE {
        Reserved1      Unsigned16,
        Header Type    HEADER_TYPE,
        Module ID      MODULE_ID,
        Station number  ST_NUM,
        Command code    RMTCTL_CMD,
        Length          LENGTH,
        RMTCTL Status   STATUS,
        RMTCTL Kind     RMTKIND,
        RMTCTL Length   RMT_LENGTH,
        RMTCTL Address  RMT_ADD,
        Send Number     SND_NUM,
        Reserved1       Unsigned16,
        Reserved2       Unsigned32
    },
    RMTCTL data     RMTCTL_DATA
}

```

4.1.1.2.3 INFO-PDU

```

INFO-PDU ::= SEQUENCE {
    IP_header      IP_HEADER,
    UDP_header     UDP_HEADER,
    INFO_data      INFOData
}

```

4.2 FAL PDU type N abstract syntax

4.2.1 Basic abstract syntax

The definitions of FALPDU are shown below.

```
FAL-PDU ::= CHOICE {
    CyclicData-PDU[0] CyclicData-PDU ,
    MulticastData-PDU [1] MulticastData-PDU ,
    PtoP Data-PDU      [2] PtoP Data-PDU ,
    Aliveinfo-PDU       [3] Aliveinfo-PDU ,
    Aliveinfo6-PDU      [4] Aliveinfo6-PDU ,
    Inq-PDU             [5] Inq-PDU ,
    Ninq-PDU            [6] Ninq-PDU ,
    Reply-PDU           [7] Reply-PDU ,
    RetransEnq-PDU      [8] RetransEnq-PDU ,
    RetransConfirm-PDU [9] RetransConfirm-PDU ,
    RetransNak-PDU     [10] RetransNak-PDU
}
```

FALAR-N Header to be used in each PDU is shown as follows.

```
FALAR-N Header ::= SEQUENCE {
    hd_h_type      Hd_h_type ,
    hd_ml          Hd_ml ,
    hd_sa          Hd_sa ,
    hd_da          Hd_da ,
    hd_v_seq       Hd_v_seq ,
    hd_seq         Hd_seq ,
    hd_m_ctl       Hd_m_ctl ,
    hd_inqid       Hd_inqid ,
    hd_tcd         Hd_tcd ,
    hd_ver         Hd_ver ,
    reserved1      OctString SIZE(3) ,
    hd_pkind       Hd_pkind ,
    hd_pseq        Hd_pseq ,
    hd_mode        Hd_mode ,
    hd_pver        Hd_pver ,
    hd_pri         Hd_pri ,
    hd_cbn         Hd_cbn ,
    hd_tbn         Hd_tbn ,
    hd_bsize       Hd_bsize ,
    reserved2      OctString SIZE(4)
}
```

```
Hd_inqid ::= SEQUENCE {
    inqid_inq_sa      Inqid_inq_sa ,
    inqid_tr_adr      Inqid_tr_adr ,
    inqid_id_seq      Inqid_id_seq
}
```

4.2.2 CyclicData-PDU

```
CyclicData-PDU ::= SEQUENCE {
    falArHeader      FALAR-N Header ,
    tmid             Tmid ,
    blockNumber       BlockNumber ,
    blockCount        BlockCount ,
    cyclicData        CyclicData
}
```

4.2.3 MulticastData-PDU

```

MulticastData-PDU ::= SEQUENCE {
    falArHeader      FALAR-N Header ,
    multicastData     MulticastData
}

```

4.2.4 PtoPData-PDU

```

PtoP Data-PDU ::= SEQUENCE {
    falArHeader      FALAR-N Header ,
    pointToPointData PointToPointData
}

```

4.2.5 Aliveinfo-PDU

```

Aliveinfo-PDU ::= SEQUENCE {
    falArHeader      FALAR-N Header ,
    alive4Header     ALIVE4 Header ,
    al_ExtentionList SEQUENCE of Al_ExtentionList ,
    al_ExtentionInfo Al_ExtenyionInfo
}

```

```

ALIVE4 Header ::= SEQUENCE {
    al_nd_name      Al_nd_name ,
    al_os_name      Al_os_name ,
    al_tm_out       Al_tm_out ,
    al_msgserno     Al_msgserno ,
    al_mode         Al_mode ,
    al_protocol     Al_protocol ,
    al_tg_cmn_cnt   Al_tg_cmn_cnt ,
    al_tg_cflag     Al_tg_cflag ,
    reserved1       OctString SIZE(1) ,
    al_tg_max       Al_tg_max ,
    al_tg_usecnt    Al_tg_usecnt ,
    al_chg_time     Al_chg_time ,
    al_ipv4addr1    Al_ipv4addr1 ,
    al_ipv4addr2    Al_ipv4addr2 ,
    al_ver          AL_ver ,
    reserved2       OctString SIZE(15)
}

```

```

Al_ExtentionList ::= SEQUENCE {
    al_ta_chgalvstat Al_ta_chgalvstat ,
    al_ta_chginfolstat Al_ta_chginfolstat ,
    al_ta_tid        Al_ta_tid ,
    al_ta_data       Al_ta_data
}

```

4.2.6 Aliveinfo6-PDU

```

Aliveinfo6-PDU ::= SEQUENCE {
    falArHeader      FALAR-N Header,
    alive6Header     ALIVE6 Header ,
    al_ExtentionList SEQUENCE of Al_ExtentionList ,
    al_ExtentionInfo Al_ExtentionInfo
}

```

```

ALIVE6 Header ::= SEQUENCE {
    al_nd_name      Al_nd_name ,
    al_os_name      Al_os_name ,
    al_tm_out       Al_tm_out ,
    al_msgserno     Al_msgserno ,

```

al_mode	Al_mode ,
al_protocol	Al_protocol ,
al_tg_cmn_cnt	Al_tg_cmn_cnt ,
al_tg_cflag	Al_tg_cflag ,
reserved1	OctString SIZE(1) ,
al_tg_max	Al_tg_max ,
al_tg_usecnt	Al_tg_usecnt ,
al_chg_time	Al_chg_time ,
reserved2	Al_ipv4addr1 ,
reserved3	Al_ipv4addr2 ,
al_ver	AL_ver ,
reserved4	OctString SIZE(15) ,
al_ipv6addr1	Al_ipv6addr1 ,
al_ipv6addr2	Al_ipv6addr2
}	

4.2.7 Inq-PDU

Inq-PDU ::= SEQUENCE {
 falArHeader FALAR-N Header ,
 inquirydata InquiryData
 }

4.2.8 Ninq-PDU

Ninq-PDU ::= SEQUENCE {
 falArHeader FALAR-N Header ,
 node-list Node-List ,
 ninquirydata NinquiryData
 }

4.2.9 Reply-PDU

Reply-PDU ::= SEQUENCE {
 falArHeader FALAR-N Header
 }

4.2.10 RetransEnq-PDU

RetransEnq-PDU ::= SEQUENCE {
 falArHeader FALAR-N Header ,
 retransRequest RetransRequest ,
 retransRequestNode RetransRequestNode ,
 retransNumberOfRequests RetransNumberOfRequests ,
 reserved1 OctString SIZE(4) ,
 retransInfo-List SEQUENCE of RetransInfoList
 }

RetransInfoList ::= SEQUENCE {
 retransMcg RetransMcg ,
 retransPseqNo RetransPseqNo
 }

4.2.11 RetransConfirm-PDU

RetransConfirm ::= SEQUENCE {
 falArHeader FALAR-N Header ,
 retransRequest RetransRequest ,
 retransNumberOfRequests RetransNumberOfRequests ,
 retransInfo-List SEQUENCE of RetransInfoList
 }

4.2.12 RetransNak-PDU

```
RetransNAK-PDU ::= SEQUENCE {
    f alArHeader          FALAR-N Header ,
    retransRequest        RetransRequest ,
    retransNumberOfRequests RetransNumberOfRequests ,
    retransInfo-List      SEQUENCE of RetransInfoList
}
```

4.3 Data type assignments for type S

Data types used in FALPDU type S abstract syntax are shown as follows.

```
BLK_Status ::= Unsigned32
BlockData  ::= OCTET STRING(SIZE=64)
BlockNum   ::= Unsigned16
CLASS      ::= Unsigned16
CLTData    ::= OCTET STRING(SIZE = 18..1472)
CYCLIC_FCS ::= Unsigned32
EntryNum   ::= Unsigned32
ERR_ADD    ::= Unsigned32
HEADER_TYPE ::= Unsigned16
INFOData   ::= OCTET STRING(SIZE = 18..1472)
IP_Header  ::= OCTET STRING(SIZE=20)
MODULE_ID  ::= Unsigned16
Node_Status ::= Unsigned32
Pattern16  ::= Unsigned16
Pattern32  ::= Unsigned32
Pattern8   ::= Unsigned8
PLD        ::= Unsigned32
PortNum    ::= Unsigned32
Priority    ::= Unsigned8
RCL_Status ::= Unsigned32
RCLCMD     ::= Unsigned32
RCLKIND    ::= Unsigned32
RMT_ADD    ::= Unsigned32
RMT_LENGTH ::= Unsigned16
RMTCTL_CMD ::= Unsigned16
RMTCTL_DATA ::= OCTET STRING(SIZE = 0..1440)
RMTKIND    ::= Unsigned16
SendTime   ::= OCTET STRING(SIZE=8)
SequenceNum32 ::= Unsigned32
SND_NUM    ::= Unsigned16
ST_Address ::= Unsigned8
ST_NUM     ::= Unsigned16
STATUS     ::= Unsigned32
TOTAL_BLOCK ::= Unsigned8
UDP_Header ::= OCTET STRING(SIZE=8)
```

4.4 Data type assignments for type N

Data types used in FALPDU type N abstract syntax are shown as follows.

```
Al_ExtentionInfo ::= OctString SIZE(0..664)
Al_chg_time      ::= Unsigned32
Al_ipv4addr1     ::= OctString SIZE(4)
Al_ipv4addr2     ::= OctString SIZE(4)
Al_ipv6addr1     ::= OctString SIZE(16)
Al_ipv6addr2     ::= OctString SIZE(16)
Al_mode          ::= Unsigned8
Al_msgsernot     ::= Unsigned16
Al_nd_name       ::= OctString SIZE(10)
```

```

Al_os_name::= OctString SIZE(10)
Al_protocol::= Unsigned8
Al_ta_chgalvstat::= Unsigned8
Al_ta_chginfostat::= Unsigned8
Al_ta_data::= interger16
Al_ta_tid::= Unsigned16
Al_tg_cflag::= Unsigned8
Al_tg_cmn_cnt::= Unsigned16
Al_tg_max::= Unsigned16
Al_tg_usecnt::= Unsigned16
Al_tm_out::= Unsigned32
AL_ver::= Unsigned8
BlockCount::= Unsigned16
BlockNumber::= Unsigned16
CyclicData::= Octstring SIZE(64..16640)
Data type assignment
Hd_bsize::= unsigned16
Hd_cbn::= unsigned8
Hd_da::= unsigned32
Hd_h_type::= unsigned32
Hd_m_ctl::= unsigned32
Hd_ml::= unsigned32
Hd_mode::= integer16
Hd_pkind::= unsigned8
Hd_pri::= unsigned8
Hd_pseq::= unsigned32
Hd_pver::= unsigned8
Hd_sa::= unsigned32
Hd_seq::= unsigned32
Hd_tbn::= unsigned8
Hd_tcd::= unsigned16
Hd_v_seq::= unsigned32
Hd_ver::= unsigned16
Inqid_id_seq::= unsigned32
Inqid_inq_sa::= unsigned32
Inqid_tr_adr::= unsigned32
InquiryData::= OctString SIZE(0..262144)
MulticastData::= OctString SIZE(0..262144)
Node-List::= OctString SIZE(512)
PointToPointData::= OctString SIZE(0..262144)
RetransMcg::= unsigned32
RetransNumberOfRequests::= unsigned32
RetransPseqNo::= unsigned32
RetransRequest::= unsigned32
RetransRequestNode::= unsigned32
Tmid::= Unsigned32

```

5 FAL transfer syntax

5.1 Encoding rules

5.1.1 Unsigned encoding

The fixed-length, unsigned values Unsigned8, Unsigned16, Unsigned24, and Unsigned32 are encoded as unsigned integers of one octet, two octets, three octets, and four octets in length, respectively. Unsigned16, Unsigned24, and Unsigned32 are encoded as big endians, where the most significant octet is regarded as the first octet, the next octet is regarded as the second octet, and the least significant octet is regarded as the last octet.

5.1.2 Octet string encoding

OctetString which has variable number of octets is encoded octet by octet, in sequential order.

5.1.3 SEQUENCE encoding

SEQUENCE encoding is performed in sequence, starting from the initial element. The identifiers and length used in ASN.1 are not used.

5.2 FALPDU type S elements encoding

5.2.1 RCL_header

5.2.1.1 Frame Class

This field shows the PDU classes described in Table 4.

Table 4 – Frame Class

Value	Description
0x0001	Class 1 frame (RHE-PDU)
0x0002	Class 2 frame (LCC-PDU, LCA-PDU, LCN-PDU, LNA-PDU, SCR-PDU)

5.2.1.2 Dst Address

5.2.1.2.1 Reserved1

This field is reserved for future use. This value is 0x00.

5.2.1.2.2 DA_STaddress

This field indicates the destination station address described in Table 5.

Table 5 – DA_STaddress – DA_STaddress

Value	Description
0xFF	RHE-PDU, LCC-PDU, LCN-PDU, SCR-PDU
SA_STaddress in the received LCC-PDU	LCA-PDU
SA_STaddress in the received LCN-PDU	LNA-PDU

5.2.1.2.3 DA_MACaddress

This field indicates the destination MAC address described in Table 6.

Table 6 – DA_MACaddress

Value	Description
FF-FF-FF-FF-FF-FF	RHE-PDU, LCC-PDU, LCN-PDU, SCR-PDU
SA_MACaddress in the received LCC-PDU	LCA-PDU
SA_MACaddress in the received LCN-PDU	LNA-PDU

5.2.1.3 Src Address

5.2.1.3.1 Reserved2

This field is reserved for future use. This value is 0x00.

5.2.1.3.2 SA_STaddress

This field indicates the station address of the own node.

5.2.1.3.3 SA_MACaddress

This field indicates the MAC address of the own node.

5.2.1.4 RCL Command

Table 7 shows RCL Command (CMD) field format. This field is used to identify the RCL frame. Each bit in this field has the following meanings:

Table 7 – CMD field format

Bit	Value						Description
	RHE	LCC	LCA	LCN	LNA	SCR	
[3:0]	1						reserved field1
[7:4]	0	0	1	2	3	0	unique number 1
[11:8]	0	1	1	1	1	3	unique number 2
[15:12]	0						reserved field2
[23:16]	1	2	2	2	2	2	indicates the frame class
[31:24]	0						reserved field3

5.2.1.5 Frame Sequence

The frame sequence number is used to detect loss and duplication of received frames. The range of this value is from 0x00000000 to 0xFFFFFFFF with step size 1.

5.2.1.6 Reserved3

This field is reserved for future use. The value is 0.

5.2.2 RHE-PDU

5.2.2.1 RHE_Common

5.2.2.1.1 Send Direction

This field contains the transmission port of the RHE-PDU as described in Table 8.

Table 8 – Send Direction

Value	Description
0x01	Port A
0x02	Port B

5.2.2.1.2 RHE Sequence

This field contains the identification number of the RHE-PDU. The range of this value is from 0x0000 to 0xFFFF. The same value is used in port A and port B.

5.2.2.2 Neighborhood address

5.2.2.2.1 Reserved1

This field is reserved for future use. The value is 0x00.

5.2.2.2.2 NB_STaddress

This field indicates the station address of the neighborhood node.

5.2.2.2.3 NB_MACaddress

This field indicates the MAC address of the neighborhood node.

5.2.2.3 RHE RecieveStatus

This field indicates the status about receiving RHE-PDU as described in Table 9.

Table 9 – RHE ReceiveStatus

Value	Description
1	Receiving RHE-PDU
0	Not receiving RHE-PDU

5.2.2.4 True Status

5.2.2.4.1 Reserved2

This field is reserved for future use. The value is 0x00000000.

5.2.2.4.2 Physical Linkdown

This field indicates the link status at the port as described in Table 10.

Table 10 – Physical Linkdown

Value	Description
1	Physical Link up
0	Physical Link down

5.2.2.4.3 Reserved3

This field is reserved for future use. The value is 0x00000000.

5.2.2.5 Blocking Status

This field indicates the status code about the port.

5.2.2.6 Node Status

This field indicates the status code about the node.

5.2.2.7 Reserved4

This field is reserved for future use. This value is 0.

5.2.2.8 Reserved5

This field is reserved for future use. This value is 0.

5.2.2.9 RHE_pattern1~4

This field is used to check the pattern of RHE-frames as described in Table 11. The patterns are repeated until the maximum length of ISO/IEC 8802-3 standard's frame.

Table 11 – RHE_pattern 1~4

Pattern	Octets	Value
RHE_pattern1	4	0xFFFFFFFF
RHE_pattern2	4	0xAAAAAAAA
RHE_pattern3	4	0x55555555
RHE_pattern4	4	0x00000000

5.2.3 LCC-PDU

5.2.3.1 LCC Kind

This field indicates the reason of sending LCC-PDU as described in Table 12.

Table 12 – LCC-Kind

Value	Description
0x00000101	Logical link up port A of the node
0x00000201	Competitive of receiving other LCC-PDU

5.2.3.2 LCC Priority

5.2.3.2.1 LCC_Priority

This field indicates the priority of LCC-PDU. This value is 0x0C.

5.2.3.2.2 LCC_STadd

This field indicates the station address of the own node.

5.2.3.2.3 LCC_MACadd

This field indicates the MAC address of the own node.

5.2.3.3 Reserved1

This field is reserved for future use. This value is 0.

5.2.4 LCA-PDU

5.2.4.1 Reserved1

This field is reserved for future use. This value is 0x01.

5.2.4.2 RCL Status

This field indicates the status of the node sending LCA-PDU as described in Table 13.

Table 13 – RCL Status

Field name	Bit	Value	Description
-	31 .. 24	0x00	Reserved
Node status	23	0 or 1	1: The node is in "Edge-A" state. When the bit 23 and 22 are "1", the node is in "Isolated" state. 0: The node is in other node status (Edge-B or Intermediate).
	22	0 or 1	1: The node is in "Edge-B" state. When the bit 23 and 22 are "1", the node is in "Isolated" state. 0: The node is in other node status (Edge-A or Intermediate).
-	21	0	Reserved
Blocking status	20	0 or 1	1: Port A or B is logical link down port.
-	19 .. 8	0x000	Reserved
Port status	7	0 or 1	1: Port A is in "Port_Linkup" state.
	6	0 or 1	1: Port B is in "Port_Linkup" state.
	5	0 or 1	1: Port A is physical link up.
	4	0 or 1	1: Port B is physical link up.
-	3 .. 0	0x0	Reserved

5.2.4.3 LCA Priority

5.2.4.3.1 LCA_Priority

This field indicates the priority in the received LCC-PDU.

5.2.4.3.2 LCA_STadd

This field indicates the station address in the received LCC-PDU.

5.2.4.3.3 LCA_MACadd

This field indicates the MAC address in the received LCC-PDU.

5.2.4.4 Reserved2

This field is reserved for future use. This value is 0.

5.2.5 LCN-PDU

5.2.5.1 Reserved1

This field is reserved for future use. This value is 0x01.

5.2.5.2 RCL Status

This field indicates the status of the node sending LCN-PDU. It has the same format as "5.2.4.2 RCL Status" described in Table 13.

5.2.5.3 Reserved2

This field is reserved for future use. This value is 0.

5.2.6 LNA-PDU

5.2.6.1 Reserved1

This field is padding area. This value is 0x00.

5.2.6.2 RCL Status

This field indicates the status of the node sending LNA-PDU. It has the same format as “5.2.4.2 RCL Status” described in Table 13.

5.2.6.3 Reserved2

This field is reserved for future use. This value is 0.

5.2.7 SCR-PDU

5.2.7.1 Entry Number

This field indicates the number to contain the SCR_Event entry.

5.2.7.2 SendStat Time

This field contains the sending time of seconds.

5.2.7.3 Reserved1

This field is reserved for future use. This value is 0.

5.2.7.4 Event0~16

This field contains the event information and specifies each manufacture.

5.2.8 Cyclic_S-PDU

5.2.8.1 IP_header

The encoding of the fields shall be according to RFC 791.

5.2.8.2 UDP_header

The encoding of the fields shall be according to RFC 768.

5.2.8.3 Reserved1

This field is reserved for future use. This value is 0x0000.

5.2.8.4 Block_number1~21

This field indicates the identification number of the cyclic data block and specifies each manufacture.

5.2.8.5 Block_num pattern

This field is used to check the Cyclic-PDU and specifies each manufacture.

5.2.8.6 Block data1~21

This field contains the cyclic data.

5.2.8.7 Cyclic_FCS

This field is an error checking code from Cyclic-PDU.

The generating polynomial is $x^{32}+x^{26}+x^{23}+x^{22}+x^{16}+x^{12}+x^{11}+x^{10}+x^8+x^7+x^5+x^4+x^2+x^1+1$.

5.2.9 Cyclic_header

5.2.9.1 Cyclic_pattern

This field is used to check the Cyclic_header and specifies each manufacture.

5.2.9.2 Total_Block

This field indicates the number of blocks in the Cyclic-PDU.

5.2.9.3 Src STaddress

This field indicates the MAC address of the own node.

5.2.9.4 Reserved1

This field is reserved for future use. This value is 0x00.

5.2.10 Control-PDU

5.2.10.1 IP_header

Refer to 5.2.8.1.

5.2.10.2 UDP_header

Refer to 5.2.8.2.

5.2.10.3 CTL_data

This field contains the data of the CTL-PDU.

5.2.11 RMTCTL-PDU

5.2.11.1 IP_header

Refer to 5.2.8.1.

5.2.11.2 UDP_header

Refer to 5.2.8.2.

5.2.11.3 RMTCTL_CMD

5.2.11.3.1 Reserved1

This field is reserved for future use. This value is 0x0000.

5.2.11.3.2 Header Type

This field is used to recognize the remote control frame. This value is “RC” in ASCII code (“RC” = 0x5243).

5.2.11.3.3 Module ID

This field indicates the module type.

5.2.11.3.4 Station number

This field indicates the station address of the destination node.

5.2.11.3.5 Command code

This field specifies the command type.

5.2.11.3.6 Length

This field indicates the length of RMTCTL-PDU.

5.2.11.3.7 RMTCTL Status

This field indicates the status code about the remote control operations.

5.2.11.3.8 RMTCTL Kind

This field indicates the module type for remote memory reading.

5.2.11.3.9 RMTCTL Length

This field indicates the data size of remote memory writing or reading.

5.2.11.3.10 RMTCTL Address

This field indicate the address of remote memory writing or reading.

5.2.11.3.11 Send Number

This field is use to manage of the remote control by the FAL-user.

5.2.11.3.12 Reserved2

This field is reserved for future use. This value is 0x0000.

5.2.11.3.13 Reserved3

This field is reserved for future use. This value is 0x00000000.

5.2.11.3.14 RMTCTL data

This field contains the data of the remote control command.

5.2.12 INFO-PDU

5.2.12.1 IP_header

Refer to 5.2.8.1.