

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Industrial communication networks – Fieldbus specifications –
Part 6-23: Application layer protocol specification – Type 23 elements**

**Réseaux de communication industriels – Spécifications des bus de terrain –
Partie 6-23: Spécification du protocole de la couche application – Éléments
de type 23**



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de type 23**

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**INDUSTRIAL COMMUNICATION NETWORKS –
FIELDBUS SPECIFICATIONS –****Part 6-23: Application layer protocol specification –
Type 23 elements**

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International Standard IEC 61158-6-23 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

The text of this standard is based on the following documents:

FDIS	Report on voting
65C/764/FDIS	65C/774/RVD

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

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- withdrawn,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

Withdrawn

0 INTRODUCTION

0.1 General

This part of IEC 61158 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 61158-1:2014.

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

0.2 Patent disclosure

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning Type 23 elements and possibly other types given in 8.1 and 8.2 as follows:

JP 05106658 US 7983177 DE 112006003943.1 KR 10-1029201 TW I338476	[MEC]	Communication management device, communication node, communication system, and data communication method
JP 4503678 DE 112006003895.8 KR 10-1024472 CN 201110218295.6 TW I333356	[MEC]	Communication management device, communication device, and communication method
JP 2010-045463 US 12/774377 DE 112006004225.4 KR 10-1024482 CN 201010148761.3 TW 099112461	[MEC]	Communication node, and token issuing method and token-ring communication method in ring communication system
JP 05127977	[MEC]	Synchronization system, time master nodes, time slave nodes and synchronization method
JP 05106658 US 13/334863 DE 112008004265.9 KR 10-2011-7030535 CN 201210026699.X TW 101108048	[MEC]	Communication management device, communication node, communication system, and data communication method

JP 2011-128274 US 13/325125 DE 112008004268.3 KR 10-2011-7029114 CN 201210127058.3 TW 101102132	[MEC]	Communication management device, communication device, and communication method
JP 05084916 US 13/142244 DE 112008004245.4 KR 10-2011-7014492 CN 200880132546.5 TW 098100145	[MEC]	Communication management device, communication device, and communication method
JP 2011-518195 US 13/377397 DE 112009004913.3 KR 10-2011-7027858 CN 200980159835.9 TW 098119663	[MEC]	Communication managing apparatus, communication nodes, and data communication method
JP 2011-532954	[MEC]	Network performance estimating apparatus, network performance estimating method, network structure recognizing method, communication managing apparatus, and data communication method

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-23: Application layer protocol specification – Type 23 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 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 23 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 standard 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; and.

The purpose of this standard is to define the protocol provided to

- a) define the wire-representation of the service primitives defined in IEC 61158-5-23, and
- b) define the externally visible behavior associated with their transfer.

This standard specifies the protocol of the IEC fieldbus Application Layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498) 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 standard to provide access to the FAL to control certain aspects of its operation.

1.2 Specifications

The principal objective of this standard is to specify the syntax and behavior of the application layer protocol that conveys the application layer services defined in IEC 61158-5-23.

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

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 61158-1:2014, *Industrial communication networks – Fieldbus specifications – Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series*

IEC 61158-5-23, *Industrial communication networks – Fieldbus specifications – Part 5-23: Application layer service definition – Type 23 elements*

IEC 61158-6, *Industrial communication networks – Fieldbus specifications – Part 6: Application layer protocol specification*

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

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

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

ISO/IEC 10731, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*

3 Terms, definitions, symbols, abbreviated terms and conventions

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

3.1 Referenced 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:

- a) application entity
- b) application process
- c) application protocol data unit
- d) application service element
- e) application entity invocation
- f) application process invocation
- g) application transaction
- h) real open system
- i) 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
- b) 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
- b) application-context
- c) application context name
- d) application-entity-invocation
- e) application-entity-type
- f) application-process-invocation
- g) application-process-type
- h) application-service-element
- i) 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
- b) type

3.1.5 IEC 61158-1 terms

For the purposes of this document, the following terms given in IEC 61158-1 apply:

- a) DLL mapping protocol machine
- b) fieldbus application layer
- c) FAL service protocol machine
- d) protocol data unit

3.2 Type 23 specific terms and definitions

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

3.2.1

cyclic transmission

transmission that is performed periodically used for the link device update

3.2.2

intelligent device station

node capable of performing 1:n bit data and word data cyclic transmission and transient transmission with the master station, and transient transmission with slave stations, excluding remote I/O stations and having client functions and server functions during transient transmission

3.2.3

link bit

link relay bit data that are shared by all the nodes through the cyclic transmission and is used as one bit unit shared memory of the n:n type

3.2.4

link device

link bit, link word, link x and link y or RX, RY, RWr, and RWw

3.2.5

link word

link register two octet unit data that are shared by all the nodes through the cyclic transmission and is used as two octet unit shared memory of the n:n type

3.2.6

link x

link input received bit data that are transmitted from each node through the cyclic transmission and is used as an input shared memory of the 1:n type

3.2.7

link y

link output bit data that are sent to each node through the cyclic transmission and is used as an output shared memory of the 1:n type

3.2.8

local station

node capable of performing n:n bit data and word data cyclic transmission and transient transmission with the master station and other local stations, and transient transmission with slave stations, excluding remote I/O stations and having server functions and client functions during transient transmission

3.2.9

management node

node in which parameters are set

3.2.10

master station

node that has control information (parameters) and manages cyclic transmission

3.2.11

node

element that forms a network and performs data transmission, receiving, and transfer

3.2.12**node-to-node test**

physical layer test between two nodes

3.2.13**normal node**

node other than a management node

3.2.14**remote device station**

node capable of performing 1:n bit data and word data cyclic transmission and transient transmission with the master station, and transient transmission with slave stations, excluding remote I/O stations and having server functions during transient transmission

3.2.15**remote I/O station**

node capable of performing 1:n bit data cyclic transmission with the master station

3.2.16**reserve node**

node that is not yet connected, but counted in the total node number of the network not performing cyclic transmission, but always regarded as normal from applications

3.2.17**RX**

remote input as viewed from the master station with bit data that are periodically updated by cyclic transmission, slave to master, or in local station as viewed from the master station is RY of the local station

3.2.18**RY**

remote output as viewed from the master station with bit data that are periodically updated by cyclic transmission, master to slave, or in local station as viewed from the master station is RX of the local station

3.2.19**RWr**

remote register (input) as viewed from the master station with word data that are periodically updated by cyclic transmission, slave to master, or in local station as viewed from the master station is RWw of the local station

3.2.20**RWw**

remote register (output) as viewed from the master station with word data that are periodically updated by cyclic transmission, master to slave, or in local station as viewed from the master station is RWr of the local station

3.2.21**slave station**

node other than the master station

3.2.22**station**

node

3.2.23

synchronization manager

node (master station role with one existing per network) that manages synchronization, distributing synchronization timing to other nodes

3.2.24

transient transmission

transmission that is performed upon each request

3.2.25

transient transmission client function

function that issues a transient request

3.2.26

transient transmission server function

function that receives a transient request and issues a response

3.2.27

transmission control manager

node (master station role with one existing per network) that performs token passing management

3.2.28

word

unit representing data, 16 bits in length

3.3 Symbols and abbreviated terms

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
ASE	Application Service Element
ASN.1	Abstract Syntax Notation 1
CRC	Cyclic Redundancy Check
DLL	Data-link Layer
DMPM	DLL Mapping Protocol Machine
FAL	Fieldbus Application Layer
FSPM	FAL Service Protocol Machine
LB	Link Bit
LSB	Least Significant Bit
LW	Link Word
LX	Link X
LY	Link Y
MSB	Most Significant Bit
OSI	Open Systems Interconnection
PDU	Protocol Data Unit

3.4 Conventions

3.4.1 General concept

The FAL is defined as a set of object-oriented ASEs. Each ASE is specified in a separate subclause. Each ASE specification is composed of three parts: its class definitions, its services, and its protocol specification. The first two are contained in IEC 61158-5-23. The protocol specification for each of the ASEs is defined in this standard.

The class definitions define the attributes of the classes supported by each ASE. The attributes are accessible from instances of the class using the Management ASE services specified in IEC 61158-5-23. The service specification defines the services that are provided by the ASE.

This standard uses the descriptive conventions given in ISO/IEC 10731.

3.4.2 Convention for the encoding of reserved bits and octets

The term "reserved" may be used to describe bits in octets or whole octets. All bits or octets that are reserved should be set to zero at the sending side and shall not be tested at the receiving side except it is explicitly stated or if the reserved bits or octets are checked by a state machine.

The term "reserved" may also be used to indicate that certain values within the range of a parameter are reserved for future extensions. In this case the reserved values should not be used at the sending side and shall not be tested at the receiving side except it is explicitly stated or if the reserved values are checked by a state machine.

3.4.3 Conventions for abstract syntax description

This description of FAL Type 23 uses a subset of ASN.1 according to ISO/IEC 8824-1. 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:

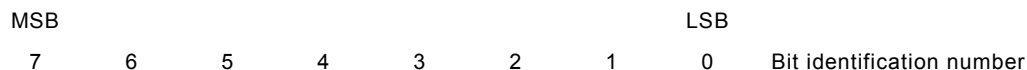
```

DLPDU ::= SEQUENCE {
    preamble      Preamble,
    sfd            SFD,
    destaddr       DestAddr,
    srcaddr        SrcAddr,
    lt             LT,
    dlsdu          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, LT, FAL-PDU and FCS.

3.4.4 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 considered 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.

3.4.5 Conventions for state machine descriptions

The state machine description is defined in tabular form as shown in Table 1. The meaning of the elements is 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 transitions to the next state.

Table 1 – State machine description elements

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

Table 2 – Description of state machine elements

Heading	Description
#	state transition name or number
Current state	current state
Next state	destination state
Event	description of event
Condition	logical expression representing the condition
=> Action	action performed upon satisfaction of the event or condition

Table 3 – Conventions used in state machines

Notation	Description
=	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"

Notation	Description
	Logical "OR"
!	Negation operator
+ - * /	Arithmetic operator
;	Breakpoint

4 FAL syntax description

4.1 FALPDU type C abstract syntax

4.1.1 Basic abstract syntax

The definitions of FALPDU are shown below.

```

FAL-PDU ::= CHOICE {
    connect-PDU           [0] Connect-PDU,
    connectAck-PDU        [1] ConnectAck-PDU,
    scan-PDU              [2] Scan-PDU,
    collect-PDU           [3] Collect-PDU,
    select-PDU            [4] Select-PDU,
    launch-PDU            [5] Launch-PDU,
    token-PDU             [6] Token-PDU,
    myStatus-PDU          [7] MyStatus-PDU,
    transient1-PDU        [8] Transient1-PDU,
    dummy-PDU             [9] Dummy-PDU,
    transient2-PDU        [10] Transient2-PDU,
    ntnTest-PDU           [11] NTNTest-PDU,
    cdata-PDU             CData-PDU
}

```

```

CData-PDU ::= CHOICE {
    cyclicDataW-PDU       [12] CyclicDataW-PDU,
    cyclicDataB-PDU       [13] CyclicDataB-PDU,
    cyclicDataOut1-PDU    [14] CyclicDataOut1-PDU,
    cyclicDataOut2-PDU    [15] CyclicDataOut2-PDU,
    cyclicDataIn1-PDU     [16] CyclicDataIn1-PDU,
    cyclicDataIn2-PDU     [17] CyclicDataIn2-PDU
}

```

FALARHeader to be used in each PDU are shown as follows.

```

FALARHeader ::= SEQUENCE {
    arFType               ARFType,
    priority               Priority,
    scanNumber            ScanNumber,
    reserved1             Unsigned8,
    srcNodeNumber         NodeNumber,
    reserved2             Unsigned16,
}

```

```

        hec
    }
    Hec

```

4.1.2 Connect-PDU

```

Connect-PDU ::= SEQUENCE {
    falArHeader      FALARHeader,
    portChoice       PortChoice,
    padding           OctetString SIZE(28),
    dcs              DCS
}

```

4.1.3 ConnectAck-PDU

```

ConnectAck-PDU ::= SEQUENCE {
    falArHeader      FALARHeader,
    portCheckResult  PortCheckResult,
    destPortInfo     DestPortInfo,
    padding           OctetString SIZE(20),
    dcs              DCS
}

```

4.1.4 Scan-PDU

```

Scan-PDU ::= SEQUENCE {
    falArHeader      FALARHeader,
    scanState        ScanState,
    sendTime         SendTime,
    padding           OctetString SIZE(20),
    dcs              DCS
}

```

4.1.5 Collect-PDU

```

Collect-PDU ::= SEQUENCE {
    falArHeader      FALARHeader,
    vendorCode       VendorCode,
    nodeType         NodeType,
    netNumber        NetNumber,
    sendTime         SendTime,
    loopState        LoopState,
    parmTypeCyclicStatus ParmTypeCyclicStatus,
    commonParamId    CommonParamId,
    padding           OctetString SIZE(8),
    dcs              DCS
}

```

```

CommonParamId ::= SEQUENCE {

```

date	ParamDate,
timeNodeId	ParamTime,
checksum	ParamChecksum
}	

4.1.6 Select-PDU

Select-PDU ::= SEQUENCE {	
falArHeader	FALARHeader,
padding	OctetString SIZE(28),
dcs	DCS
}	

4.1.7 Launch-PDU

Launch-PDU ::= SEQUENCE {	
falArHeader	FALARHeader,
padding	OctetString SIZE(28),
dcs	DCS
}	

4.1.8 Token-PDU

Token-PDU ::= SEQUENCE {	
falArHeader	FALARHeader,
padding	OctetString SIZE(28),
dcs	DCS
}	

4.1.9 MyStatus-PDU

MyStatus-PDU ::= SEQUENCE {	
falArHeader	FALARHeader,
reserved1	Unsigned16,
nodeType	NodeType,
netNumber	NetNumber,
reserved2	Unsigned16,
loopState	LoopState,
parmTypeCyclicStatus	ParmTypeCyclicStatus,
commonParamId	CommonParamId,
inFarNodeMACAddr	MACAddress,
inFarNodeNumber	NodeNumber,
reserved3	Unsigned8,
outFarNodeMACAddr	MACAddress,
outFarNodeNumber	NodeNumber,
reserved4	Unsigned8,
opState	OpState,
errorState	ErrorState,

errorCode	ErrorCode,
vendorCode	VendorCode,
deviceType	DeviceType,
unitTypeName	UnitTypeName,
unitTypeCode	UnitTypeCode,
reserved5	Unsigned16,
nodeInfo	NodeInfo,
dcs	DCS
}	

4.1.10 Transient1-PDU

Transient1-PDU ::= SEQUENCE {	
falArHeader	FALARHeader,
destinationGroup	DestinationGroup,
seqNumber	SeqNumber,
dataId	TraDataId,
wholeDataSize	TraWholeDataSize,
offsetAddr	TraOffsetAddr,
dataSize	TraDataSize,
dataType	TraDataType,
data	TraData,
evenPadding	[0] Unsigned8 OPTIONAL,
dcs	DCS
}	

4.1.11 Dummy-PDU

Dummy-PDU ::= SEQUENCE {	
falArHeader	FALARHeader,
dummyData	OctetString SIZE(28..1482),
dcs	DCS
}	

4.1.12 Transient2-PDU

Transient2-PDU ::= SEQUENCE {	
falArHeader	FALARHeader,
l	Length,
gcnt	GateCount,
typeSeqF	TypeSeqF,
fno	FrameSequence,
dt	DataFrameType,
da	TraDstAddr,
sa	TraSrcAddr,
dat	TraDstAppType,
sat	TraSrcAppType,
dmf	TraDstModuleFlag,

smf	TraSrcModuleFlag,
dna	TraDstNetAddr,
ds	TraDstStaNo,
did	TraDstID,
sna	TraSrcNetAddr,
ss	TraSrcStaNo,
sid	TraSrcID,
l1	TraCmdLen,
ct	TraCmdType,
rsv	Unsigned8,
aps	TraAppSeq,
data	[0] TraData OPTIONAL,
evenPadding	[1] Unsigned8 OPTIONAL,
dcs	DCS
}	

4.1.13 NTNTest-PDU

```

NTNTest-PDU ::= SEQUENCE {
    falArHeader    FALARHeader,
    ntnTestData    NTNTestData,
    dcs            DCS
}

```

4.1.14 CyclicDataW-PDU

```

CyclicDataW-PDU ::= SEQUENCE {
    falArHeader    FALARHeader,
    seqNumber      SeqNumber,
    byteValidity    ByteValidity,
    dataSize        CycDataSize,
    offsetAddr      CycOffsetAddr,
    exSeqNumber     CycExSeqNumber,
    reserved        Unsigned16,
    wData           CycWData,
    evenPadding     [0] Unsigned8 OPTIONAL,
    dcs            DCS
}

```

4.1.15 CyclicDataB-PDU

```

CyclicDataB-PDU ::= SEQUENCE {
    falArHeader    FALARHeader,
    seqNumber      SeqNumber,
    byteValidity    ByteValidity,
    dataSize        CycDataSize,
    offsetAddr      CycOffsetAddr,
    reserved1       Unsigned16,
}

```

reserved2	Unsigned16,
bData	CycBData,
evenPadding	[0] Unsigned8 OPTIONAL,
dcs	DCS
}	

4.1.16 CyclicDataOut1-PDU

CyclicDataOut1-PDU ::= SEQUENCE {

falArHeader	FALARHeader,
seqNumber	SeqNumber,
byteValidity	ByteValidity,
dataSize	CycDataSize,
offsetAddr	CycOffsetAddr,
reserved1	Unsigned16,
reserved2	Unsigned16,
out1Data	CycOut1Data,
evenPadding	[0] Unsigned8 OPTIONAL,
dcs	DCS

}

4.1.17 CyclicDataOut2-PDU

CyclicDataOut2-PDU ::= SEQUENCE {

falArHeader	FALARHeader,
seqNumber	SeqNumber,
byteValidity	ByteValidity,
dataSize	CycDataSize,
offsetAddr	CycOffsetAddr,
reserved1	Unsigned16,
reserved2	Unsigned16,
out2Data	CycOut2Data,
evenPadding	[0] Unsigned8 OPTIONAL,
dcs	DCS

}

4.1.18 CyclicDataIn1-PDU

CyclicDataIn1-PDU ::= SEQUENCE {

falArHeader	FALARHeader,
seqNumber	SeqNumber,
byteValidity	ByteValidity,
dataSize	CycDataSize,
offsetAddr	CycOffsetAddr,
reserved1	Unsigned16,
reserved2	Unsigned16,
in1Data	CycIn1Data,
evenPadding	[0] Unsigned8 OPTIONAL,

dcS	DCS
}	

4.1.19 CyclicDataIn2-PDU

CyclicDataIn2-PDU ::= SEQUENCE {	
falArHeader	FALARHeader,
seqNumber	SeqNumber,
byteValidity	ByteValidity,
dataSize	CycDataSize,
offsetAddr	CycOffsetAddr,
reserved1	Unsigned16,
reserved2	Unsigned16,
in2Data	CycIn2Data,
evenPadding	[0] Unsigned8 OPTIONAL,
dcS	DCS
}	

4.2 FALPDU type F abstract syntax

4.2.1 Basic abstract syntax

The definitions of FALPDU are shown below.

FAL-PDU ::= CHOICE {	
f-channelControl-PDU	F-ChannelControl-PDU,
f-sync-PDU	F-Sync-PDU,
f-cyclicData-PDU	F-CData-PDU,
f-transientData-PDU	F-TraData-PDU
}	

F-ChannelControl-PDU ::= CHOICE {	
persuasion-PDU	[16] Persuasion-PDU,
testData-PDU	[17] TestData-PDU,
testDataAck-PDU	[18] TestDataAck-PDU,
setup-PDU	[19] Setup-PDU,
setupAck-PDU	[20] SetupAck-PDU,
token-PDU	[21] F-Token-PDU,
myStatus-PDU	[32] F-MyStatus-PDU
}	

F-Sync-PDU ::= CHOICE {	
measure-PDU	[50] F-Measure-PDU,
measureAck-PDU	[51] F-Measure-PDU,
offset-PDU	[52] F-Offset-PDU,
update-PDU	[53] F-Update-PDU
}	

```

F-CData-PDU ::= CHOICE {
    cyclicDataRWw-PDU          [130] F-CyclicData-PDU,
    cyclicDataRY-PDU           [131] F-CyclicData-PDU,
    cyclicDataRWr-PDU          [132] F-CyclicData-PDU,
    cyclicDataRX-PDU           [133] F-CyclicData-PDU
}

```

```

F-TraData-PDU ::= CHOICE {
    transient1-PDU              [34] Transient1-PDU,
    transientAck-PDU            [35] TransientAck-PDU,
    transient2-PDU              [37] Transient2-PDU,
    paramCheck-PDU              [40] ParamCheck-PDU,
    parameter-PDU               [41] Parameter-PDU,
    timer-PDU                   [44] Timer-PDU
}

```

The following shows the FALARHeader used in each PDU.

```

FALAR-FHeader ::= SEQUENCE {
    arFType                    ARFType,
    dataType                    DataType,
    varField                    CHOICE {
        vField0 [0] SEQUENCE {
            persPriority          PersPriority,
            nodeType              NodeType
        },
        vField1 [1] SEQUENCE {
            reserved1              OCTET STRING (SIZE (4))
        },
        vField2 [2] SEQUENCE {
            nodeId                 NodeId,
            reserved2              OCTET STRING (SIZE (2))
        },
        vField3 [3] SEQUENCE {
            nodeId                 NodeId,
            syncFlag               SyncFlag,
            nodeType               NodeType
        },
        vField4 [4] SEQUENCE {
            nodeId                 NodeId,
            connectionInfo         ConnectionInfo,
            reserved4              OCTET STRING (SIZE (1))
        }
    },
    srcNodeNumber              NodeNumber,
    protocolVerType            ProtocolVerType,
    reserved                    OCTET STRING (SIZE (1)),
}

```

hec	Hec
}	

4.2.2 Persuasion-PDU

Persuasion-PDU ::= SEQUENCE {	
falArHeader	FALAR-FHeader,
reserved1	OCTET STRING (SIZE (1)),
myPorts	Unsigned8,
vendorCode	VendorCode,
modelCode	ModelCode,
reserved2	OCTET STRING (SIZE (20)),
dcs	DCS
}	

4.2.3 TestData-PDU

TestData-PDU ::= SEQUENCE {	
falArHeader	FALAR-FHeader,
tmMacAddr	MACAddress,
srcPort	PortNumber,
reserved	OCTET STRING (SIZE (21)),
dcs	DCS
}	

4.2.4 TestDataAck-PDU

TestDataAck-PDU ::= SEQUENCE {	
falArHeader	FALAR-FHeader,
tdSrcMacAddr	MACAddress,
tdSrcPort	PortNumber,
tdRcvPort	PortNumber,
reserved1	OCTET STRING (SIZE (1)),
myPorts	Unsigned8,
tokenKeepTime	Unsigned16,
reserved2	OCTET STRING (SIZE (4)),
myConnectStatus	SEQUENCE {
port2port1	PortStatus,
port4port3	PortStatus,
port6port5	PortStatus,
port8port7	PortStatus,
port10port9	PortStatus,
port12port11	PortStatus,
port14port13	PortStatus,
port16port15	PortStatus,
port18port17	PortStatus,
port20port19	PortStatus,
port22port21	PortStatus,
	}

```

        port24port23      PortStatus
    },
    dcs                    DCS
}

```

4.2.5 Setup-PDU

```

Setup-PDU ::= SEQUENCE {
    falArHeader            FALAR-FHeader,
    tokenDstMacAddr        MACAddress,
    reserved1              OCTET STRING (SIZE (2)),
    leaveTimerValue        LeaveTimer,
    portUsage              PortUsage,
    reserved2              OCTET STRING (SIZE (1)),
    netBehaviour           NetworkBehaviour,
    reserved3              OCTET STRING (SIZE (12)),
    dcs                    DCS
}

NetworkBehaviour ::= SEQUENCE {
    multipleTranmit        Unsigned8,
    frameInterval          Unsigned8,
    reserved               OCTET STRING (SIZE (1)),
    multipleTokens         Unsigned8
}

```

4.2.6 SetupAck-PDU

```

SetupAck-PDU ::= SEQUENCE {
    falArHeader            FALAR-FHeader,
    slaveNodeInfo          SlaveNodeInfo,
    fwVersion              Version,
    deviceType             DeviceType,
    reserved1              OCTET STRING (SIZE (2)),
    vendorCode             VendorCode,
    modelCode              ModelCode,
    rySize                 Unsigned16,
    rwwSize                Unsigned16,
    rxSize                 Unsigned16,
    rwrSize                Unsigned16,
    reserved2              OCTET STRING (SIZE (2)),
    availableFuncs         AvailableFuncs,
    reserved3              OCTET STRING (SIZE (5)),
    dcs                    DCS
}

```

4.2.7 F-Token-PDU

```

F-Token-PDU ::= SEQUENCE {
    falArHeader          FALAR-FHeader,
    tokenDstMacAddr      MACAddress,
    tokenSeqNumber       Unsigned8,
    reserved1            OCTET STRING (SIZE (1)),
    tokenHopCounter      Unsigned16,
    traAvailHopCounter   Unsigned16,
    traLastHopCounter    Unsigned16,
    traAllows            Unsigned8,
    reserved2            OCTET STRING (SIZE (13)),
    dcs                  DCS
}

```

4.2.8 F-MyStatus-PDU

```

F-MyStatus-PDU ::= SEQUENCE {
    falArHeader          FALAR-FHeader,
    seqNumber            SeqNumber,
    netNumber            NetNumber,
    masterCmd            Unsigned16,
    cyclicStatus         Unsigned16,
    nodeStatus           Unsigned16,
    errorCode            ErrorCode,
    portStatus           SEQUENCE {lower PortStatus,
                                upper PortStatus },
    portStatistics       SEQUENCE {lower PortStatistics,
                                upper PortStatistics },
    portIndex            Unsigned8,
    reserved             OCTET STRING (SIZE (3)),
    cyclicSeqNumber      Unsigned8,
    addrTableDistResult  Unsigned8,
    slaveSpfEventInfo1   Unsigned8,
    slaveSpfEventInfo2   Unsigned16,
    vendorSpfNodeInfo    OCTET STRING (SIZE (4)),
    dcs                  DCS
}

```

4.2.9 Measure-PDU

```

F-Measure-PDU ::= SEQUENCE {
    falArHeader          FALAR-FHeader,
    reserved             OCTET STRING (SIZE (28)),
    dcs                  DCS
}

```

4.2.10 F-Offset-PDU

```

F-Offset-PDU ::= SEQUENCE {

```

<pre> falArHeader reserved syncOffset reserved2 dcs </pre>	<pre> FALAR-FHeader, OCTET STRING (SIZE (8)), SyncOffset, OCTET STRING (SIZE (16)), DCS </pre>
--	--

4.2.11 F-Update-PDU

<pre> F-Update-PDU ::= SEQUENCE { </pre>	
<pre> falArHeader reserved syncOffset reserved2 dcs </pre>	<pre> FALAR-FHeader, OCTET STRING (SIZE (8)), SyncOffset, OCTET STRING (SIZE (16)), DCS </pre>
<pre> } </pre>	

4.2.12 F-CyclicData-PDU

<pre> F-CyclicData-PDU ::= SEQUENCE { </pre>	
<pre> falArHeader seqNumber bothEndsValidity cycDataSize offsetAddr reserved cycData dcs </pre>	<pre> FALAR-FHeader, SeqNumber, BothEndsValidity, Unsigned16, CycOffsetAddr, OCTET STRING (SIZE (4)), CycData, DCS </pre>
<pre> } </pre>	

4.2.13 Transient1-PDU

<pre> Transient1-PDU ::= SEQUENCE { </pre>	
<pre> falArHeader traMsgHeader data dcs </pre>	<pre> FALAR-FHeader, TraMsgHeader, OCTET STRING (SIZE (12..1466)), DCS </pre>
<pre> } </pre>	

<pre> TraMsgHeader ::= SEQUENCE { </pre>	
<pre> reserved seqNumber dataId wholeDataSize offsetAddr dataSize dataSubType </pre>	<pre> OCTET STRING (SIZE (4)), SeqNumber, TraDataId, TraWholeDataSize, TraOffsetAddr, TraDataSize, TraDataSubType </pre>

}

```

FieldSpecificTransient ::= SEQUENCE {
    opHeader                TraMsgCmdExHeader,
    fSTraData                CHOICE {
        nodeInfoDist        [721] TraSysNodeInfoDist,
        statisticsGet        [723] TraSysStatisticsGet,
        nodeInfoDetailGet    [724] TraSysNodeInfoDetailGet,
        ...
    }
}

```

```

TraMsgCmdExHeader ::= SEQUENCE {
    command                TraCommand,
    subCommand              TraSubCommand,
    rtn                    CHOICE {
        reserved            [0] OCTET STRING (SIZE (2)),
        value                [1] Unsigned16
    },
    reserved1              OCTET STRING (SIZE (1)),
    destNetNumber          NetNumber,
    destNodeNumber         NodeNumber,
    reserved2              OCTET STRING (SIZE (5)),
    srcNetNumber           NetNumber,
    srcNodeNumber          NodeNumber,
    reserved3              OCTET STRING (SIZE (4))
}

```

```

TraSysNodeInfoDist ::= SEQUENCE {
    seqNumber              SeqNumber,
    masterNetNumber        NetNumber,
    masterDeviceType       DeviceType,
    masterModelCode        ModelCode,
    masterVendorCode       VendorCode,
    masterNodeType         NodeType,
    Reserved1              OCTET STRING (SIZE (1)),
    masterMacAddress        MACAddress
    Reserved2              OCTET STRING (SIZE (2)),
    dataNum                Unsigned32,
    messages               SEQUENCE OF
                           NodeInfoMessage
}

```

```

NodeInfoMessage ::= SEQUENCE {
    nodeNumber             NodeNumber,
    reserved1              OCTET STRING (SIZE (1)),
    availableFuncs         AvailableFuncs,

```

reserved2	OCTET STRING (SIZE (1)),
netNumber	NetNumber,
deviceType	DeviceType,
modelCode	ModelCode,
vendorCode	VendorCode,
nodeType	NodeType,
reserved3	OCTET STRING (SIZE (1)),
macAddress	MACAddress,
reserved4	OCTET STRING (SIZE (2))

```

}

TraSysStatisticsGet ::= CHOICE {
    statGetRequest          [0] SEQUENCE {
    },
    statGetResponse        [1] SEQUENCE {
        port1Mib1           Unsigned32,
        port1Mib2           Unsigned32,
        port1Mib3           Unsigned32,
        port1Mib4           Unsigned32,
        port1Mib5           Unsigned32,
        port1Mib6           Unsigned32,
        port1Mib7           Unsigned32,
        reserved            OCTET STRING (SIZE (4)),
        port2Mib1           Unsigned32,
        port2Mib2           Unsigned32,
        port2Mib3           Unsigned32,
        port2Mib4           Unsigned32,
        port2Mib5           Unsigned32,
        port2Mib6           Unsigned32,
        port2Mib7           Unsigned32,
        healthStatusNum     Unsigned32,
        healthStatus        SEQUENCE SIZE (0..128) OF
                           Unsigned32
    }
}
    
```

```

TraSysNodeInfoDetailGet ::= CHOICE {
    nodeInfoDetailGetRequest [0] SEQUENCE {
    },
    nodeInfoDetailGetResponse [1] SEQUENCE {
        rySize           Unsigned16,
        rwwSize          Unsigned16,
        rxSize           Unsigned16,
        rwrSize          Unsigned16,
        reserved1        OCTET STRING (SIZE (1)),
        ports            Unsigned8,
        tokenKeepTime    Unsigned16,
    }
}
    
```

netBehaviour	NetworkBehaviour,
nodeInfo	SlaveNodeInfo,
fwVersion	Version,
deviceType	DeviceType,
modelCode	ModelCode,
vendorCode	VendorCode,
reserved2	OCTET STRING (SIZE (2)),
modelName	OCTET STRING (SIZE (20)),
vendorName	OCTET STRING (SIZE (32)),
contInfo	Unsigned8,
contFwVersion	Version,
contDeviceType	DeviceType,
contModelCode	ModelCode,
contVendorCode	VendorCode,
reserved3	OCTET STRING (SIZE (2)),
contModelName	OCTET STRING (SIZE (20)),
contVendorName	OCTET STRING (SIZE (32)),
contVendorSpecificInfo	OCTET STRING (SIZE (4))
}	
}	

4.2.14 TransientAck-PDU

TransientAck-PDU ::= SEQUENCE {	
falArHeader	FALAR-FHeader,
acks	Unsigned32,
ackData	SEQUENCE OF TraAckData,
dcs	DCS
}	

4.2.15 Transient2-PDU

Transient2-PDU ::= SEQUENCE {	
falArHeader	FALAR-FHeader,
reserved	TraLength,
tp	OCTET STRING (SIZE (1)),
fno	TraType,
dt	TraFrameSequence,
da	TraDataFrameType,
sa	TraDstAddr,
dat	TraSrcAddr,
sat	TraDstAppType,
dmf	TraSrcAppType,
smf	TraDstModuleFlag,
dna	TraSrcModuleFlag,
ds	TraDstNetAddr,
	TraDstStaNo,

did	TraDstID,
sna	TraSrcNetAddr,
ss	TraSrcStaNo,
sid	TraSrcID,
l1	TraCmdLen,
ct	TraCmdType,
dno	TraDataNo,
aps	TraAppSeq,
rsts	TraReturnStatus,
data	Tra2Data,
dcs	DCS
}	

4.2.16 ParamCheck-PDU

```
ParamCheck-PDU ::= SEQUENCE {
    falArHeader      FALAR-FHeader,
    reserved1        OCTET STRING (SIZE (4)),
    paramId          CommonParamId,
    reserved2        OCTET STRING (SIZE (12)),
    dcs              DCS
}
```

```
CommonParamId ::= SEQUENCE {
    date             ParamDate,
    timeNodeId      ParamTime,
    checksum         ParamChecksum
}
```

4.2.17 Parameter-PDU

```
Parameter-PDU ::= SEQUENCE {
    falArHeader      FALAR-FHeader,
    paramSetFlag     ParamFlag,
    addressOrder     AddressOrder,
    cmdOrder         CmdOrder,
    cyclicParameter   CyclicParameter,
    dcs              DCS
}
```

```
AddressOrder ::= SEQUENCE {
    assignedNetNumber    NetNumber,
    assignedNodeNumber   NodeNumber
}
```

```
CmdOrder ::= SEQUENCE {
    cmd                 Unsigned24,
```

nodeType	NodeType
}	
CyclicParameter ::= SEQUENCE {	
paramId	CommonParamId,
reserved1	OCTET STRING (SIZE (2)),
masterStatus	Unsigned16,
rySeqNumber	SeqNumber,
ryBothEndsValidity	BothEndsValidity,
ryDataSize	Unsigned16,
ryOffset	Unsigned16,
reserved2	OCTET STRING (SIZE (2)),
rwwSeqNumber	SeqNumber,
reserved3	OCTET STRING (SIZE (1)),
rwwDataSize	Unsigned16,
rwwOffset	Unsigned16,
reserved4	OCTET STRING (SIZE (3)),
rxBothEndsValidity	BothEndsValidity,
rxDataSize	Unsigned16,
rxOffset	Unsigned32,
reserved5	OCTET STRING (SIZE (2)),
rwrDataSize	Unsigned16,
rwrOffset	Unsigned32,
reserved6	OCTET STRING (SIZE (4)),
masterWatchTimer	Unsigned16,
reserved7	OCTET STRING (SIZE (3)),
cmRyBothEndsValidity	BothEndsValidity,
cmRyDataSize	Unsigned16,
cmRyOffset	Unsigned32,
reserved8	OCTET STRING (SIZE (2)),
cmRwwDataSize	Unsigned16,
cmRwwOffset	Unsigned32,
reserved9	OCTET STRING (SIZE (1)),
cmRxBothEndsValidity	BothEndsValidity,
cmRxDataSize	Unsigned16,
cmRxOffset	Unsigned32,
reserved10	OCTET STRING (SIZE (2)),
cmRwrDataSize	Unsigned16,
cmRwrOffset	Unsigned32
}	

4.2.18 Timer-PDU

Timer-PDU ::= SEQUENCE {	
falArHeader	FALAR-FHeader,
time	Timer,
reserved	OCTET STRING (SIZE (22)),

```

        dcs
    }
    DCS

```

4.3 Data type assignments for type C

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

```

ARFType ::= Unsigned8
DCS ::= Unsigned8
Priority ::= Unsigned8
ScanNumber ::= Unsigned24
NodeNumber ::= Unsigned16
Hec ::= Unsigned32
PortChoice ::= Unsigned32
PortCheckResult ::= Unsigned32
DestPortInfo ::= Unsigned32
ScanState ::= Unsigned32
SendTime ::= Unsigned16
VendorCode ::= Unsigned16
NodeType ::= Unsigned8
NetNumber ::= Unsigned8
LoopState ::= Unsigned8
ParamTypeCyclicStatus ::= Unsigned8
ParamDate ::= Unsigned32
ParamTime ::= Unsigned32
ParamChecksum ::= Unsigned32
OpState ::= Unsigned16
ErrorState ::= Unsigned16
ErrorCode ::= Unsigned16
DeviceType ::= Unsigned16
UnitTypeName ::= VisibleString SIZE(20)
UnitTypeCode ::= Unsigned16
NodeInfo ::= OctetString SIZE(96)
DestinationGroup ::= Unsigned32
SeqNumber ::= Unsigned8
TraDataId ::= Unsigned8
TraWholeDataSize ::= Unsigned16
TraOffsetAddr ::= Unsigned32
TraDataSize ::= Unsigned16
TraDataType ::= Unsigned16
TraData ::= LOctetString SIZE(12..1466)
Length ::= Unsigned16
GateCount ::= Unsigned8
TypeSeqF ::= Unsigned8
FrameSequence ::= Unsigned8
DataFrameType ::= Unsigned8
TraDstAddr ::= Unsigned8
TraSrcAddr ::= Unsigned8
TraDstAppType ::= Unsigned8
TraSrcAppType ::= Unsigned8
TraDstModuleFlag ::= Unsigned8
TraSrcModuleFlag ::= Unsigned8
TraDstNetAddr ::= Unsigned8
TraDstStaNo ::= Unsigned8
TraDstID ::= Unsigned16
TraSrcNetAddr ::= Unsigned8
TraSrcStaNo ::= Unsigned8
TraSrcID ::= Unsigned16
TraCmdLen ::= Unsigned16
TraCmdType ::= Unsigned8
TraAppSeq ::= Unsigned16
Tra2Data ::= LOctetString SIZE(12..1466)
NTNTestData ::= OctetString SIZE(28..1480)
ByteValidity ::= Unsigned8
CycDataSize ::= Unsigned16
CycOffsetAddr ::= Unsigned32
CycExSeqNumber ::= Unsigned16

```

```
CycWData ::= LOctetString SIZE(16..1468)
CycBData ::= LOctetString SIZE(16..1468)
CycOut1Data ::= LOctetString SIZE(16..1468)
CycOut2Data ::= LOctetString SIZE(16..1468)
CycIn1Data ::= LOctetString SIZE(16..1024)
CycIn2Data ::= LOctetString SIZE(16..1024)
```

4.4 Data type assignments for type F

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

```
DCS ::= Unsigned32
ARFType ::= Unsigned8
DataType ::= Unsigned8
NodeNumber ::= Unsigned16
ProtocolVerType ::= Unsigned8
Hec ::= Unsigned32
PersPriority ::= Unsigned24
NodeType ::= Unsigned8
NodeId ::= Unsigned16
ConnectionInfo ::= Unsigned8
VendorCode ::= Unsigned16
ModelCode ::= Unsigned32
PortNumber ::= Unsigned8
TraControl ::= Unsigned8
PortStatus ::= Unsigned8
LeaveTimer ::= Unsigned16
PortUsage ::= Unsigned8
SlaveNodeInfo ::= Unsigned8
Version ::= Unsigned8
DeviceType ::= Unsigned16
AvailableFuncs ::= Unsigned8
SeqNumber ::= Unsigned8
NetNumber ::= Unsigned8
PortStatistics ::= Unsigned8
ErrorCode ::= Unsigned32
ParamFlag ::= Unsigned8
ParamDate ::= Unsigned32
ParamTime ::= Unsigned32
ParamChecksum ::= Unsigned32
Timer ::= Unsigned48
TraDataSubType ::= Unsigned16
TraDataId ::= Unsigned8
TraReturnValue ::= Unsigned16
TraWholeDataSize ::= Unsigned16
TraOffsetAddr ::= Unsigned32
TraDataSize ::= Unsigned16
TraCommand ::= Unsigned8
TraSubCommand ::= Unsigned8
TraLength ::= Unsigned16
TraType ::= Unsigned8
TraFrameSequence ::= Unsigned8
TraDataFrameType ::= Unsigned8
TraDstAddr ::= Unsigned8
TraSrcAddr ::= Unsigned8
TraDstAppType ::= Unsigned8
TraSrcAppType ::= Unsigned8
TraDstModuleFlag ::= Unsigned8
TraSrcModuleFlag ::= Unsigned8
TraDstNetAddr ::= Unsigned8
TraDstStaNo ::= Unsigned8
TraDstID ::= Unsigned16
TraSrcNetAddr ::= Unsigned8
TraSrcStaNo ::= Unsigned8
TraSrcID ::= Unsigned16
TraCmdLen ::= Unsigned16
TraCmdType ::= Unsigned8
TraDataNo ::= Unsigned8
```

```
TraAppSeq ::= Unsigned16
TraReturnStatus ::= Unsigned16
Tra2Data ::= LOctetString (SIZE(0..960))
BothEndsValidity ::= Unsigned8
CycOffsetAddr ::= Unsigned32
CycData ::= LOctetString
OctetString ::= OCTET STRING
BitString8 ::= OCTET STRING (SIZE (1))
BitString16 ::= OCTET STRING (SIZE (2))
BitString32 ::= OCTET STRING (SIZE (3))
Unsigned8 ::= OCTET STRING (SIZE (1))
Unsigned16 ::= OCTET STRING (SIZE (2))
Unsigned24 ::= OCTET STRING (SIZE (3))
Unsigned32 ::= OCTET STRING (SIZE (4))
Unsigned48 ::= OCTET STRING (SIZE (6))
MACAddress ::= OCTET STRING (SIZE (6))
LOctetString ::= OCTET STRING
SyncOffset ::= Unsigned32
SyncFlag ::= Unsigned8
```

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 length of octets is encoded octet by octet, in sequential order.

5.1.3 SEQUENCE encoding

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

5.1.4 LOctetString encoding

LOctetString has variable length and is encoded as little endian, where the lowest, or least significant, octet is ordered as the first octet, and follow in sequential order until the highest, or most significant, octet is ordered last.

5.2 FALPDU type C elements encoding

5.2.1 FALARHeader

5.2.1.1 arFType

This field shows the PDU types described in Table 4.

Table 4 – afFType

Value	Description
0x00	Connect-PDU
0x01	ConnectAck-PDU

Value	Description
0x02	Scan-PDU
0x03	Collect-PDU
0x04	Select-PDU
0x05	Launch-PDU
0x06	Token-PDU
0x07..0x1F	Reserved
0x20	MyStatus-PDU
0x22	Transient1-PDU
0x23	Reserved
0x24	Dummy-PDU
0x25	Transient2-PDU
0x26..0x2E	Reserved
0x2F	NTNTest-PDU
0x30..0x7F	Reserved
0x80	CyclicDataW-PDU
0x81	CyclicDataB-PDU
0x82..0x8B	Reserved
0x8C	CyclicDataOut1-PDU
0x8D	CyclicDataOut2-PDU
0x8E	CyclicDataIn1-PDU
0x8F	CyclicDataIn2-PDU

5.2.1.2 priority

This field shows priorities described in Table 5.

Table 5 – priority

Value	Description
0x00	Select-PDU, Launch-PDU, Token-PDU, Dummy-PDU, CyclicDataW-PDU, CyclicDataB-PDU, CyclicDataOut1-PDU, CyclicDataOut2-PDU, CyclicDataIn1-PDU, CyclicDataIn2-PDU
0x01	Collect-PDU, Connect-PDU, ConnectAck-PDU, Scan-PDU
0x02	MyStatus-PDU
0x03	Transient1-PDU

Value	Description
0x04	Transient2-PDU, NTNTest-PDU

5.2.1.3 scanNumber

This field contains a frame identifier used in Scan-PDU. The number is incremented each time when sending Scan-PDU. The default value of 0x000000 is used in all other PDUs.

5.2.1.4 reserved1

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

5.2.1.5 srcNodeNumber

This field contains the identifier number of the source node.

5.2.1.6 reserved2

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

5.2.1.7 hec

This field is an error checking code from DestAddr of DLPDU to reserved2 of FALARHeader. DLPDU definitions are as follows.

```

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

```

```

Preamble ::= OctetString SIZE(7)
SFD       ::= OctetString SIZE(1)
DestAddr  ::= MACAddress
SrcAddr    ::= MACAddress
LT         ::= Unsigned16
FCS        ::= OctetString SIZE(4)

```

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

5.2.2 Connect-PDU

5.2.2.1 falArHeader

Refer to 5.2.1.

5.2.2.2 portChoice

This field shows the port types as described in Table 6.

Table 6 – portChoice

Value	Description
0x0	“In” side
0x1	“Out” side
0xF	“Out” side, during Test between nodes

5.2.2.3 padding

This field is padding. The value is 0x00.

5.2.2.4 dcs

This field is an error checking code from DestAddr of DLPDU. For DLPDU definitions, refer to 5.2.1.7.

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

5.2.3 ConnectAck-PDU**5.2.3.1 falArHeader**

Refer to 5.2.1.

5.2.3.2 portCheckResult

This field shows the check results of In-Out connection. The values are specified in Table 7.

Table 7 – portCheckResult

Value	Description
0x0	OK
0x1	NG
0xE	Node-to-node test OK
0xF	Node-to-node test NG

5.2.3.3 dstPortInfo

This field shows the destination port types. The values are specified in Table 8.

Table 8 – dstPortInfo

Value	Description
0	“In” side
1	“Out” side

5.2.3.4 padding

This field is padding. The value is 0x00.

5.2.3.5 dcs

Refer to 5.2.2.4.

5.2.4 Scan-PDU

5.2.4.1 falArHeader

Refer to 5.2.1.

5.2.4.2 scanState

This field shows the status of transmission path. The values are specified in Table 9.

Table 9 – scanState

Value	Description
0	Through status
1	Loopback status of “In” side
2	Loopback status of “Out” side

5.2.4.3 sendTime

This field indicates the sent time.

5.2.4.4 padding

This field is a padding. The value is 0x00.

5.2.4.5 dcs

Refer to 5.2.2.4.

5.2.5 Collect-PDU

5.2.5.1 falArHeader

Refer to 5.2.1.

5.2.5.2 vendorCode

This field shows the vendor code. For vendor codes, refer to implementation rules.

5.2.5.3 nodeType

This field shows the node types as described in Table 10.

Table 10 – nodeType

Value	Description
0x00	Management node
0x01	Reserve (for future expansion)
0x02	Normal node
0x10	Reserve (for future expansion)
0x12	Reserve (for future expansion)
0x20	Reserve (for future expansion)
0x21	Master node in the Node-to-node test

5.2.5.4 netNumber

This field contains the identifier of the network to which the node belongs. The range is 1..239.

5.2.5.5 sendTime

Refer to 5.2.4.3.

5.2.5.6 loopState

This field shows the loop status of the node. The values are specified in Table 11.

Table 11 – loopState

Value	Description
0x00	Through
0x12	Loop back to “In” side, “Out” side disconnected
0x13	Loop back to “In” side, In/Out check error in “Out” side
0x14	Loop back to “In” side, In/Out check being performed at “Out” side
0x21	“In” side disconnected, loop back to “Out” side
0x31	In/Out check error at “In” side, loop back to “Out” side
0x41	In/Out check being performed at “In” side, loop back to “Out” side

5.2.5.7 parmTypeCyclicStatus

This field is divided as follows:

- Bit 0..5 Cyclic status – follow values in Table 12
- Bit 6..7 Parameter setting mode – follow values in Table 13

Table 12 – Cyclic status

Value	Description
0x00	Cyclic transmission is not performed
0x01	Cyclic transmission is performed
0x02	Common parameters not received
0x03	Receiving common parameters
0x04	Common parameters error
0x05	Reserved
0x06	The node number is illegal
0x07	Reserve node setting
0x08	Cyclic stop instruction
0x09	Performing off-line test
0x0A	Monitor timer time out
0x0B	Node number not set
0x0C	The node CPU error
0x0D	The node number duplication
0x0E	The management node duplication
0x0F	The node number and own management node duplication

Value	Description
0x10	Network number error

Table 13 – Parameter setting mode

Value	Description
0x0	Common parameter
0x1	Reserved

5.2.5.8 commonParamId

5.2.5.8.1 date

The bits of this field are defined as follows:

Bit 28..31	Year (hundreds digit)
Bit 24..27	Year (thousands digit)
Bit 20..23	Year (ones digit)
Bit 16..19	Year (tens digit)
Bit 12..15	Month (ones digit)
Bit 8..11	Month (tens digit)
Bit 4..7	Day (ones digit)
Bit 0..3	Day (tens digit)

If all bits are 0, there are no common parameters.

5.2.5.8.2 timeNodeId

The bits of this field are defined as follows:

Bit 28..31	Hours (ones digit)
Bit 24..27	Hours (tens digit)
Bit 20..23	Minutes (ones digit)
Bit 16..19	Minutes (tens digit)
Bit 12..15	Seconds (ones digit)
Bit 8..11	Seconds (tens digit)
Bit 0..7	Node number of setting reference

If all bits are 0, there are no common parameters.

5.2.5.8.3 checksum

This field contains the checksum of “date” and “time_nodeId” in the commandParamId. If all bits are 0, there are no common parameters.

5.2.5.9 padding

This field is 8 octets in length. The value is 0x00 for all 8 octets.

5.2.5.10 dcs

Refer to 5.2.2.4.

5.2.6 Select-PDU**5.2.6.1 falArHeader**

Refer to 5.2.1.

5.2.6.2 padding

This field is padding. The value is 0x00.

5.2.6.3 dcs

Refer to 5.2.2.4.

5.2.7 Launch-PDU**5.2.7.1 falArHeader**

Refer to 5.2.1.

5.2.7.2 padding

This field is padding. The value is 0x00.

5.2.7.3 dcs

Refer to 5.2.2.4.

5.2.8 Token-PDU**5.2.8.1 falArHeader**

Refer to 5.2.1.

5.2.8.2 padding

This field is padding. The value is 0x00.

5.2.8.3 dcs

Refer to 5.2.2.4.

5.2.9 MyStatus-PDU**5.2.9.1 falArHeader**

Refer to 5.2.1.

5.2.9.2 reserved1

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

5.2.9.3 nodeType

Refer to 5.2.5.3.

5.2.9.4 netNumber

Refer to 5.2.5.4.

5.2.9.5 reserved2

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

5.2.9.6 loopState

Refer to 5.2.5.6.

5.2.9.7 parmTypeCyclicStatus

Refer to 5.2.5.7.

5.2.9.8 commonParamId

Refer to 5.2.5.8.

5.2.9.9 inFarNodeMACAddr

This field indicates the MAC address of the node connected with “In” side. If the “In” side is not connected correctly, the value is 0.

5.2.9.10 inFarNodeNumber

This field indicates the node number of the node connected with “In” side.

5.2.9.11 reserved3

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

5.2.9.12 outFarNodeMACAddr

This field indicates the MAC address of the node connected with “Out” side. If the “Out” side is not connected correctly, the value is 0.

5.2.9.13 outFarNodeNumber

This field indicates the node number of the node connected with “Out” side.

5.2.9.14 reserved4

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

5.2.9.15 opState

This field indicates the status of a node. The values are specified in Table 14.

Table 14 – opState

Value	Description
0	Controller does not exist
1	Controller is stopped
2	Controller is operating

5.2.9.16 errorState

This field indicates the error status of a node. The values are specified in Table 15.

Table 15 – errorState

Value	Description
0	No error
1	Minor error
2	Major error
3	Severe error

5.2.9.17 errorCode

This field indicates the error codes of errors that occurred in a node. Error codes and their meanings are not defined here.

5.2.9.18 vendorCode

Refer to 5.2.5.2.

5.2.9.19 deviceType

This field specifies the device type. For device types, refer to device profile.

5.2.9.20 unitTypeName

This field contains the character string for model name.

5.2.9.21 unitTypeCode

This field contains the model name code.

5.2.9.22 reserved5

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

5.2.9.23 nodeInfo

This field indicates the user-defined node status.

5.2.9.24 dcs

Refer to 5.2.2.4.

5.2.10 Transient1-PDU**5.2.10.1 falArHeader**

Refer to 5.2.1.

5.2.10.2 destinationGroup

This field specifies the destination group. Each bit represents a group address. Bit 0 shows group address 1. Bit 31 shows group address 32. If no destination group is specified, the values of all bits are 0.

5.2.10.3 seqNumber

Each bit in this field has the following meanings:

Bit 0..6	Shows the number for data fragments.
Bit 7	Shows if the data is the last fragment. The value 0 means that it is not the last PDU. The value 1 means that it is the last PDU of the last fragment.

5.2.10.4 dataId

This field contains the identification number of the transient data. The range of values is 0x00..0xFF. All fragments of a transient data transmission have the same identification number.

5.2.10.5 wholeDataSize

This field specifies the amount of transient data in octets.

5.2.10.6 offsetAddr

This field specifies the offset address. In the initial PDU, the value is 0x0. In subsequent PDUs, the position within the entire transient data is shown as an offset address from the initial PDU.

5.2.10.7 dataSize

This field specifies the fragmented transient data size in octets. The range of values is 0x0000..0x05BA.

5.2.10.8 dataType

This field specifies the data type as described in Table 16.

Table 16 – Data type

Value	Description
0	Parameter delivery
1	Reserved

5.2.10.9 data

5.2.10.9.1 Overview

The data field contains the transient data. The structure depends on the type of transient data. If wholeDataSize exceeds 1466 octets, it is the transient data from offset described in offsetAddr to the data size described in dataSize. If the transient data has less than 16 octets, the padding is filled with 0x00

5.2.10.9.2 Structure for parameter delivery

When the data type is parameter delivery, the data are selected from CPW, CPWC or CPWCR. The structure of CPW is described in Table 17, that of CPWC in Table 18 and that of CPWCR in Table 19. Each field is encoded as LOctetString.