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Industrial communication networks –
Fieldbus specifications –
Part 6-23: Application layer protocol specification – Type 23 elements
(IEC 61158-6-23:2014);
English version EN 61158-6-23:2014, only on CD-ROM

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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Anwendungsbeginn

Anwendungsbeginn für die von CENELEC am 2014-09-23 angenommene Europäische Norm als DIN-Norm ist 2015-09-01.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN EN 61158-600:2013-08.

Für dieses Dokument ist das nationale Arbeitsgremium K 956 „Feldbus“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE (www.dke.de) zuständig.

Die enthaltene IEC-Publikation wurde vom SC 65C „Industrial networks“ erarbeitet.

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Der Zusammenhang der zitierten Dokumente mit den entsprechenden Deutschen Dokumenten ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

Das Präsidium des DIN hat mit Präsidialbeschluss 1/2004 festgelegt, dass DIN-Normen, deren Inhalt sich auf internationale Arbeitsergebnisse der Informationsverarbeitung gründet, unter bestimmten Bedingungen allein in englischer Sprache veröffentlicht werden dürfen. Diese Bedingungen sind für die vorliegende Norm erfüllt.

Da sich die Benutzer der vorliegenden Norm der englischen Sprache als Fachsprache bedienen, wird die Englische Fassung der EN 61158-6-23 veröffentlicht. Zu deren Abschnitt 1, der den Anwendungsbereich festlegt, und Abschnitt 3, der die Begriffe festlegt, wurde eine Übersetzung angefertigt und als Nationaler Anhang NA der vorliegenden Norm hinzugefügt. Für viele der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Einführung

Ein Feldbus ist ein digitaler serieller Datenbus für die Kommunikation zwischen Geräten der industriellen Automatisierungstechnik wie beispielsweise Messeinrichtungen, Stellgliedern, Reglern und speicherprogrammierbaren Steuerungen. Die Normen der Reihe DIN EN 61158 legen eine Anzahl von Feldbus-Protokolltypen fest. Die vorliegende Norm legt das Protokoll des Application Layer für Typ 23 fest.

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Nationaler Anhang NA
(informativ)

1 Anwendungsbereich[N1)]

1.1 Allgemeines

Der Feldbus-Application Layer (FAL) liefert Benutzerprogramme mit Hilfsmitteln für den Zugriff auf die Feldbus Kommunikationsumgebung. In dieser Hinsicht, kann die FAL als ein Fenster zwischen zugehörigen Anwendungsprogrammen betrachtet werden.

Diese Norm stellt für Typ 23-Feldbusse maßgebliche allgemeine Elemente für zeitkritischen und nicht zeitkritischen Datentransfer zwischen Anwendungsprogrammen in einer Automatisierungsumgebung bereit. Der Begriff „zeitkritisch“ (en: time-critical) wird verwendet, um die Präsenz eines Zeitfensters darzustellen, in dem eine oder mehrere festgelegte Aktivitäten mit einem vorbestimmten Grad an Gewissheit erledigt werden. Das Scheitern der Erledigung der festgelegten Aktivität innerhalb des Zeitfensters trägt das Risiko des Betriebsausfalls der Anwendung mit und somit das aufgeforderte Eingreifen mit dazugehörigem Risiko für Geräte, Anlagen und möglicherweise Menschenleben.

Diese Norm definiert auf eine abstrakte Weise das von außen sichtbare Verhalten, der von verschiedenen Typen des Feldbus-Application Layer bereitgestellt wird, in Form von:

a) einer abstrakten Syntax zur Festlegung der Application Layer-Protokoll-Dateneinheiten die zwischen kommunizierenden Anwendungseinheiten übermittelt werden,

b) der übertragenen Syntax zur Festlegung der Application Layer-Protokoll-Dateneinheiten die zwischen kommunizierenden Anwendungseinheiten übermittelt werden,

c) des Anwendungskontext der Zustandsmaschine zur Festlegung des sichtbaren Dienstverhalten zwischen kommunizierenden Anwendungseinheiten,

d) der Anwendungsbeziehung der Zustandsmaschine zur Festlegung des sichtbaren Kommunikationsverhalten zwischen kommunizierenden Anwendungseinheiten.

Der Zweck dieser Norm ist, das Protokoll zu definieren, welches bereitgestellt wird zur

- Festlegung der Leitungsdarstellung der Dienstprimitiven, welche in IEC 61158-5-23 beschrieben sind und
- zur Festlegung des von außen sichtbaren Verhaltens verbunden mit ihrer Übertragung.

Diese Norm beschreibt das Protokoll des IEC-Feldbus-Application Layer in Übereinstimmung mit dem OSI Basis Referenzmodell (ISO/IEC 7498-1) und der OSI Application Layer-Struktur (ISO/IEC 9545).

FAL Dienste und Protokolle sind von FAL-Applikations-Einheiten (AE) bereitgestellt, welche innerhalb von Anwendungsprozessen enthalten sind. Die FAL-AE besteht aus einer Menge von objekt-orientierten Anwendungs-Dienst-Elementen (ASEs) und Layer-Management-Einheiten (LME) welche die AE leiten. Die ASEs liefern Kommunikationsdienste, die auf einer Menge von zugehörigen Applikationsprozessobjekt (APO) -Klassen arbeitet. Eine der FAL-ASEs ist eine Management ASE, welche eine allgemeine Menge von Diensten für das Management der Instanzen der FAL-Klassen bereitstellt.

Obwohl diese Dienste, aus dem Blickwinkel der Anwendung, beschreiben wie Anfrage und Antwort ausgegeben und abgegeben werden, beinhalten sie keine Festlegung was die anfragende und antwortende Anwendungen mit diesen vorzunehmen haben. Die Verhaltensaspekte der Anwendungen sind nicht festgelegt, nur eine Definition von welchen Anfragen und Antworten diese senden/empfangen können, ist beschrieben. Dies erlaubt den FAL-Benutzern eine größere Flexibilität, um solch ein Objektverhalten zu standardisieren. Zusätzlich zu diesen Diensten, sind in dieser Norm ebenfalls einige Dienste zur Unterstützung festgelegt, um den Zugriff zur FAL bereitzustellen und somit bestimmte Aspekte des Betriebs zu steuern.

[N1)] Die Nummerierung aus IEC 61158-6-23 wurde beibehalten.

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1.2 Spezifikationen

Das hauptsächliche Ziel dieser Norm, ist das Festlegen der Syntax und des Verhaltens des Application Layer-Protokolls, welcher die in IEC 61158-5-23 beschriebenen Application Layer-Dienste, vermittelt.

Ein zweites Ziel, ist das Bereitstellen von Migrationspfade von bisherigen bestehenden industriellen Kommunikationsprotokollen. Es ist dieses letztere Ziel, welches zur Verschiedenheit von Protokollen, die in Teilen der IEC 61158-6 genormt werden, führt.

1.3 Konformität

Diese Norm legt keine individuellen Implementierungen oder Produkte fest, noch beschränkt sie die Implementierungen von Application Layer-Einheiten innerhalb eines industriellen Automatisierungssystems.

Es gibt keine Konformität von Geräten zu dieser Application Layer-Dienstdefinitionsnorm. Stattdessen wird Konformität durch das Implementieren dieser Application Layer-Protokoll-Spezifikation erreicht.

3.2 Spezifische Begriffe für Typ 23

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

3.2.1
zyklische Übertragung
(en: cyclic transmission)
periodisch durchgeführte Übertragung zur Aktualisierung des Link-Gerätes

3.2.2
intelligente Gerätestation
(en: intelligent device station)
Knoten, der die zyklische und transiente Übertragung von 1:n-Bitdaten und -Wortdaten mit der Master-Station sowie die transiente Übertragung mit Slave-Stationen, außer entfernten E/A-Stationen, ausführen kann und während der transienten Übertragung über Client- und Server-Funktionen verfügt

3.2.3
Link-Bit
(en: link bit)
auf dem Verbindungszweig weitergegebene Bitdaten, die von allen Knoten bei der zyklischen Übertragung gemeinsam genutzt werden; wird als ein in Biteinheiten organisierter gemeinsamer Speicher des n:n-Typs genutzt

3.2.4
Link-Gerät
(en: link device)
Link-Bit, Link-Wort, Link x und Link y oder RX, RY, RWr und RWw

3.2.5
Link-Wort
(en: link word)
auf dem Verbindungszweig eingetragene zwei Oktetten-Dateneinheit, die von allen Knoten bei der zyklischen Übertragung gemeinsam genutzt werden und verwendet als Einheit von zwei Oktetten mit gemeinsamen Speicher des n:n-Typs

3.2.6
Link x
(en: link x)
auf dem Verbindungszweig empfangene Bit-Eingangsdaten, die von jedem Knoten bei der zyklischen Übertragung übermittelt werden und als gemeinsamer Eingangsspeicher für den 1:n-Typ verwendet

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3.2.7
Link y
(en: link y)
Bit-Ausgangsdaten auf dem Verbindungszweig, die bei der zyklischen Übertragung an jeden Knoten gesendet werden und als gemeinsamer Ausgangsspeicher für den 1:n-Typ verwendet

3.2.8
lokale Station
(en: local station)
Knoten, der die zyklische und transiente Übertragung von n:n-Bitdaten und -Wortdaten mit der Master-Station und anderen lokalen Stationen sowie die transiente Übertragung mit Slave-Stationen, außer entfernten E/A-Stationen, ausführen kann und während der transienten Übertragung über Server- und Client-Funktionen verfügt

3.2.9
Steuerungsknoten
(en: management node)
Knoten, in dem Parameter festgelegt werden

3.2.10
Master-Station
(en: master station)
Knoten, der über Steuerungsinformationen (Parameter) verfügt und die zyklische Übertragung regelt

3.2.11
Knoten
(en: node)
Element, das ein Netzwerk bildet und die Datenübertragung, den Empfang und den Transfer ausführt

3.2.12
Knoten-zu-Knoten-Prüfung
(en: node-to-node test)
Prüfung zwischen zwei Knoten auf dem Physical Layer

3.2.13
normaler Knoten
(en: normal node)
anderer Knoten als ein Steuerungsknoten

3.2.14
entfernte Gerätestation
(en: remote device station)
Knoten, der die zyklische und transiente Übertragung von 1:n-Bitdaten und -Wortdaten mit der Master-Station sowie die transiente Übertragung mit Slave-Stationen, außer entfernten E/A-Stationen, ausführen kann und während der transienten Übertragung über Server-Funktionen verfügt

3.2.15
entfernte E/A-Station
(en: remote I/O station)
Knoten, der die zyklische und transiente Übertragung von 1:n-Bitdaten mit der Master-Station ausführen kann

3.2.16
reservierter Knoten
(en: reserve node)
Knoten, der noch nicht verbunden ist, aber in der Gesamtknotenzahl des Netzwerks enthalten ist und der keine zyklische Übertragung ausführt, aber von Anwendungen als normaler Knoten betrachtet wird

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3.2.17
RX
(en: RX)
entferntes Register (Eingang), aus der Sicht der Master-Station, mit Bitdaten, die durch die zyklische Übertragung periodisch aktualisiert werden, vom Slave zum Master, oder in einer lokalen Station, aus der Sicht der Master-Station, die RY der lokalen Station ist

3.2.18
RY
(en: RY)
entferntes Register (Ausgang) aus der Sicht der Master-Station mit Bitdaten, die durch zyklische Übertragung periodisch aktualisiert werden, vom Master zum Slave, oder in einer lokalen Station, aus der Sicht der Master-Station, die RX der lokalen Station ist

3.2.19
RWr
(en: RWr)
entferntes Register (Eingang), aus der Sicht der Master-Station, mit Wortdaten, die durch zyklische Übertragung periodisch aktualisiert werden, vom Slave zum Master, oder in einer lokalen Station, aus der Sicht der Master-Station, die RWw der lokalen Station ist

3.2.20
RWw
(en: RWw)
entferntes Register (Ausgang), aus der Sicht der Master-Station, mit Wortdaten, die durch zyklische Übertragung periodisch aktualisiert werden, vom Master zum Slave, oder in einer lokalen Station, aus der Sicht der Master-Station, die RWr der lokalen Station ist

3.2.21
Slave-Station
(en: slave station)
anderer Knoten als die Master-Station

3.2.22
Station
(en: station)
Knoten

3.2.23
Synchronisationsmanager
(en: synchronization manager)
Knoten (Rolle der Master-Station, die je Netzwerk einmal vorhanden ist), der die Synchronisation steuert und die Synchronisationssteuerung an andere Knoten verteilt

3.2.24
transiente Übertragung
(en: transient transmission)
Übertragung, die auf jede Anforderung hin ausgeführt wird

3.2.25
Client-Funktion bei der transienten Übertragung
(en: transient transmission client function)
Funktion, die eine transiente Anforderung ausgibt

3.2.26
Server-Funktion bei der transienten Übertragung
(en: transient transmission server function)
Funktion, die eine transiente Anforderung empfängt und eine Antwort ausgibt

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3.2.27
Übertragungssteuerungsmanager
(en: transmission control manager)
Knoten (Rolle der Master-Station, die je Netzwerk einmal vorhanden ist), der die Tokenweitergabe steuert

3.2.28
Wort
(en: word)
Einheit, die Daten repräsentiert und 16 Bit lang ist

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Foreword

The text of document 65C/764/FDIS, future edition 1 of IEC 61158-6-23, prepared by SC 65C "Industrial networks" of IEC/TC 65 "Industrial-process measurement, control and automation" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61158-6-23:2014.

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) 2015-06-23
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2017-09-23

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In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61784-1	NOTE	Harmonized as EN 61784-1.
IEC 61784-2	NOTE	Harmonized as EN 61784-2.

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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

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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

IEC takes no position concerning the evidence, validity and scope of these patent rights.

The holders of these patent rights have assured IEC that they are willing to negotiate licenses either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holders of these patent rights is registered with IEC. Information may be obtained from:

[MEC] Mitsubishi Electric Corporation
Corporate Licensing Division
7-3, Marunouchi 2-chome, Chiyoda-ku,
Tokyo 100-8310, Japan

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

ISO (www.iso.org/patents) and IEC (http://patents.iec.ch) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the data bases for the most up to date information concerning patents.

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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.

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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.

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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

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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

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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, salve 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 salve, 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

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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

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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 check 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.

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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”
||	Logical ”OR”
!	Negation operator
+ - * /	Arithmetic operator
;	Breakpoint

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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
}
```


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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
}
```


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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
}
```


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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
}
```


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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
}
```


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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
}
```


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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.

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```
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
}
```


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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
}
```


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```
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
}
```


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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 {
    falArHeader          FALAR-FHeader,
    reserved             OCTET STRING (SIZE (8)),
    syncOffset           SyncOffset,
    reserved2            OCTET STRING (SIZE (16)),
    dcs                  DCS
}
```

4.2.11 F-Update-PDU

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


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4.2.12 F-CyclicData-PDU

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

4.2.13 Transient1-PDU

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

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

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


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```
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))
}
```


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```
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)),
```


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```
        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,
    l               TraLength,
    reserved        OCTET STRING (SIZE (1)),
    tp              TraType,
    fno             TraFrameSequence,
    dt              TraDataFrameType,
    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,
    dno             TraDataNo,
    aps             TraAppSeq,
```


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```
        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,
```


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```
        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.

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```
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
ParmTypeCyclicStatus ::= 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)
```


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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
```


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```
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.

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Table 4 – afFType

Value	Description
0x00	Connect-PDU
0x01	ConnectAck-PDU
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
0x04	Transient2-PDU, NTNTest-PDU

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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

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

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.

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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 vender 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.

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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
0x10	Network number error

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