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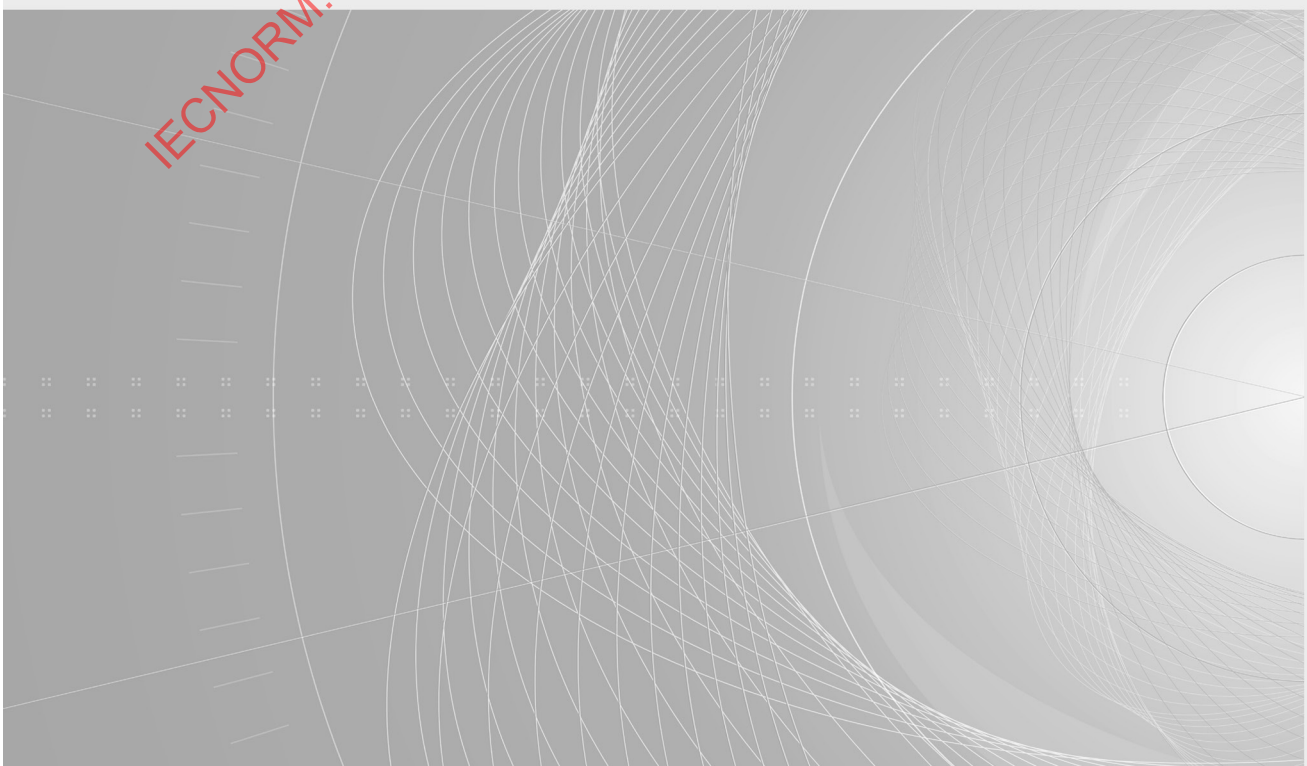
INTERNATIONAL STANDARD

Industrial communication networks – Fieldbus specifications –
Part 5-24: Application layer service definition – Type 24 elements



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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 5-24: Application layer service definition – Type 24 elements

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NOTE Combinations of protocol types are specified in the IEC 61784-1 series and the IEC 61784-2 series.

IEC 61158-5-24 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation. It is an International Standard.

This second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

a) modify to the AP type definition in Table 1;

b) modify to the Support list of service for each class of FDC ASE in Table 8.

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

Draft	Report on voting
65C/1203/FDIS	65C/1244/RVD

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

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

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

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

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

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- withdrawn,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

INTRODUCTION

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

The application service is provided by the application protocol making use of the services available from the data-link or other immediately lower layer. This document defines the application service characteristics that fieldbus applications and/or system management can exploit.

Throughout the set of fieldbus standards, the term "service" refers to the abstract capability provided by one layer of the OSI Basic Reference Model to the layer immediately above. Thus, the application layer service defined in this document is a conceptual architectural service, independent of administrative and implementation divisions.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 5-24: Application layer service definition – Type 24 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 document 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 24 fieldbus. The term "time-critical" is used to represent the presence of a time-window, within which one or more specified actions are required to be completed with some defined level of certainty. Failure to complete specified actions within the time window risks failure of the applications requesting the actions, with attendant risk to equipment, plant and possibly human life.

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

- an abstract model for defining application resources (objects) capable of being manipulated by users via the use of the FAL service,
- the primitive actions and events of the service,
- the parameters associated with each primitive action and event, and the form which they take, and
- the interrelationship between these actions and events, and their valid sequences.

The purpose of this International Standard is to define the services provided to

- the FAL user at the boundary between the user and the Application Layer of the Fieldbus Reference Model, and
- Systems Management at the boundary between the Application Layer and Systems Management of the Fieldbus Reference Model.

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

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

Although these services specify, from the perspective of applications, how request and responses are issued and delivered, they do not include a specification of what the requesting and responding applications are to do with them. That is, the behavioral aspects of the applications are not specified; only a definition of what requests and responses they can send/receive is specified. This permits greater flexibility to the FAL users in standardizing such object behavior. In addition to these services, some supporting services are also defined in this document to provide access to the FAL to control certain aspects of its operation.

1.2 Specifications

The principal objective of this document is to specify the characteristics of conceptual application layer services suitable for time-critical communications, and thus supplement the OSI Basic Reference Model in guiding the development of application layer protocols for time-critical communications.

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 services standardized as the various Types of IEC 61158, and the corresponding protocols standardized in subparts of the IEC 61158-6 series.

This document can be used as the basis for formal Application Programming-Interfaces. Nevertheless, it is not a formal programming interface, and any such interface will need to address implementation issues not covered by this specification, including

- the sizes and octet ordering of various multi-octet service parameters, and
- the correlation of paired request and confirm, or indication and response, primitives.

1.3 Conformance

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

There is no conformance of equipment to this application layer service definition standard. Instead, conformance is achieved through implementation of conforming application layer protocols that fulfil any given Type of application layer services as defined in this part of IEC 61158.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE All parts of the IEC 61158 series, as well as the IEC 61784-1 series and the IEC 61784-2 series 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 61158-1:2023, *Industrial communication networks – Fieldbus specifications – Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series*

IEC 61158-4-24:2023, *Industrial communication networks – Fieldbus specifications – Part 4-24: Data link layer protocol specification – Type 24 elements*

IEC 61158-6-24:2023, *Industrial communication networks – Fieldbus specifications – Part 6-24: Application layer protocol specification – Type 24 elements*

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

ISO/IEC 8824-1, *Information technology – Abstract Syntax Notation One (ASN.1) – Part 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, abbreviated terms and conventions apply.

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

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

3.1 Referenced terms and definitions

3.1.1 ISO/IEC 7498-1 terms

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

a) abstract syntax;
b) application-entity;
c) application process;
d) application protocol data unit;
e) application-process-invocation;
f) (N)-facility;
g) (N)-function;
h) correspondent-(N)-entities;
i) presentation context;
j) real system;
k) transfer syntax.

3.1.2 ISO/IEC 9545 terms

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

a) application-association;
b) application-context;
c) application-entity-invocation;
d) application-entity-type;
e) application-service-element.

3.1.3 ISO/IEC 8824-1 terms

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

a) object identifier.

3.1.4 Terms and definitions from ISO/IEC 10731

For the purposes of this document, the following terms as defined in ISO/IEC 10731 apply:

a) OSI-service-primitive; primitive;

b) OSI-service-provider; provider;

c) OSI-service-user; user.

3.2 Additional terms and definitions

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

3.2.1
alarm
field device status to tell that the device has detected a fatal problem to be solved and cannot continue normal working, through the field device control (FDC) service of the type 24 fieldbus

Note 1 to entry: Any alarm statuses are latched and need some operation to be cleared.

Note 2 to entry: Alarms are classified into three groups; communication alarms, illegal-command-related ones, and application specific ones. But concrete definitions are dependent on implementation of each field devices.

3.2.2
application process object
network representation of a specific aspect of an application process (AP), which is modelled as a network accessible object contained within an AP or within another APO

Note 1 to entry: Refer IEC 61158-1, 9.3.4.

3.2.3
application process context
AP context
shared knowledge or a common set of rules, governing communication of FAL application entities (AEs) and describing the permissible collective communications behavior between the AEs that are party to a specific set of application relationships (ARs)

Note 1 to entry: Data within AP context can be specified by the user in advance, by the option selected while the user uses a field bus management (FSM) service to read out the facility of peer AP, by the automatic negotiation function that the FSM system handles, and so on. The method that is to be adopted depends on the specification of each implementation.

3.2.4
application process type
AP type
description of a classification of application processes (APs) in terms of a set of capabilities for FAL of the type 24 fieldbus

Note 1 to entry: AP types are classified into three ones, C1 master AP, C2 master AP and slave AP, by their application roles in the fieldbus network. See 6.2.

3.2.5
async command
type of a command application protocol data unit (APDU) of the FDC service of the type 24 FAL, which can be issued any time after the previous transaction without consideration of synchronization with the communication cycle

Note 1 to entry: Definitions, which command should be async one or not, are dependent on an application. They can be provided as a registered set of commands and responses or device profiles (see IEC 61158-6-24, 4.4 and Annex A).

3.2.6
asynchronous communication
state or a way of communication for the FDC service of the type 24 FAL, in which a command can be issued any time after the previous transaction without consideration of synchronization with the communication cycle

Note 1 to entry: In this state, sync commands cannot be issued, but async commands can.

3.2.7
attribute
information or parameter contained in variable portions of an object

Note 1 to entry: Typically, they provide status information or govern the operation of an object. Attributes also affect the behavior of an object.

3.2.8
C1 master
AP type that has master facilities for the FDC service of the type 24 FAL, or the device implementing that AP type

Note 1 to entry: Only one C1 master exists in a network of the type 24 fieldbus

3.2.9
C2 master
AP type that has only monitor facilities for the FDC service but requester facilities for message (MSG) service of the type 24 FAL, or the device implementing that AP type

Note 1 to entry: Less than two C2 masters can exist in a network of the type 24 fieldbus

3.2.10
command
PDU issued by a requester or a master to make a responder or a slave execute some functions

3.2.11
communication
process to exchange information in a formal manner between two or more devices, users, APs or entities

3.2.12
transfer
process to convey a PDU from a sender to a receiver

3.2.13
transmission
process to send out and propagate electrical signals or encoded data

3.2.14
communication cycle
period of repetitive activities synchronized with the transmission cycle while the connection establishing for the FDC protocol of the type 24 FAL

Note 1 to entry: Communication cycle can synchronize with a cycle multiplying the transmission cycle by a specified scaling factor.

3.2.15
connection
context or logical binding under specific conditions for the FDC protocol between a master object and a slave object for the type 24 FAL

3.2.16
cyclic
repetitive in a regular manner

3.2.17
cyclic communication
transmission mode in which request PDUs and response PDUs are exchanged repetitively in the scheduled time slots synchronized with a transmission cycle for the lower layer protocol of the type 24 fieldbus

Note 1 to entry: In the AL, the communication cycle arises from the transmission cycle in this mode.

3.2.18
cycle scale counter
counter to generate a communication cycle by means of scaling a primary cycle or a transmission cycle

3.2.19
device ID
part of "device information" to identify the device for a specific product type or model of the type 24 fieldbus

3.2.20
device information
formatted and device-embedded information to characterize a device, which mainly consists of data for device model identification and device-profile specific parameters for the type 24 fieldbus

3.2.21
device profile
collection of device model-common information and functionality providing consistency between different device models among the same kind of devices

3.2.22
dual transfer
transfer mode for the FDC protocol of the type 24 FAL, in which a sender sends a same PDU twice a transaction and a receiver uses them to detect and recover a communication error such as data-corruption or data-loss in cyclic communication mode

3.2.23
event driven communication
transmission mode for the lower layer protocol of the type 24 fieldbus in which a transaction of command-response-exchanging arises as user's demands

Note 1 to entry: Both the transmission cycle and the communication cycle don't arise in this mode.

3.2.24
error
abnormal condition or malfunction for communication or any other activities

3.2.25
field device control service
FDC service
time-critical communication service that handles a fixed length command data to control a field device and the corresponding feedback response data in a severe restriction on delay or jitter for the communication timing for the type 24 FAL

3.2.26
field device control protocol
time-critical communication protocol that handles a fixed length command data to control a field device and the corresponding feedback response data in a severe restriction on delay or jitter for the communication timing for the type 24 FAL

3.2.27
master
class or its instance object of FDC application service element (ASE) who plays a role of a command requester for the type 24 FAL

3.2.28
message service
MSG service
communication service that handles the variable length data and not required a severe restriction on response time

3.2.29
monitor
class or its instance object of FDC ASE who plays a role of a watcher or subscriber of commands and response between other communication nodes for the type 24 FAL

3.2.30
monitor slave
variant of slave AP type who has both slave class and monitor class for FDC ASE of the type 24 FAL

3.2.31
network clock
synchronized and periodically running counter that each node in a same network has, which becomes an oscillation source of the transmission cycle

3.2.32
protocol machine
state machine that realizes the protocol as the main function of the entity in each layer

3.2.33
requester
class or its instance object of MSG ASE who plays a role of a command requester or sender for the type 24 FAL

3.2.34
responder
class or its instance object of MSG ASE who plays a role of a command responder or receiver for the type 24 FAL

3.2.35
response
PDU issued by a responder or a slave to inform a result or some status for the received command to a requester or a master

3.2.36
service
operation or process that an object performs upon request from another object

3.2.37
single transfer
normal transfer mode for the FDC protocol of the type 24 FAL in which a sender sends a same PDU once a transaction

3.2.38
slave AP
AP type that has slave facilities for the FDC service of the type 24 FAL, or the device implementing that AP type

3.2.39
slave
FDC slave
class or its instance object of FDC ASE who plays a role of a responder for the type 24 FAL

3.2.40
state machine
logical automatic machine or automaton that has a finite number of states and handles state transition fired by an event as a trigger

3.2.41
sync command
type of command or APDU of the FDC service of the type 24 FAL, which is issued at the synchronized timing with every communication cycle

Note 1 to entry: Definitions which command should be sync one or not are dependent on an application. They can be provided as a registered set of commands and responses or device profiles (see IEC 61158-6-24, 4.4 and Annex A).

3.2.42
synchronous communication
state or a way of communication for the FDC service of the type 24 FAL, in which a command is issued at the synchronized timing with every communication cycle

Note 1 to entry: In this state, both sync commands and async ones can be issued.

Note 2 to entry: In this state, an out-of-synchronization error of APs shall be detected by measures of the watchdog counter.

3.2.43
transmission cycle
period of repetitive activities for the lower layers of the type 24 fieldbus, which of all the slave devices are synchronized with that of a C1 master device by the lower layer protocol

3.2.44
transmission mode
state or a way of transmission for the lower layer protocol of the type 24 fieldbus; cyclic mode, event driven mode

3.2.45
virtual memory space
large data block of APOs for the type 24 FAL which can be read and write with pseudo-memory-addresses to provide consistency between different device models

Note 1 to entry: The virtual memory space includes the device information and other vender specific area. See IEC 61158-6-24, Annex B.

3.2.46
warning
field device status to tell that the device has detected a slight or passing problem but still working normally through the field device control (FDC) service of the type 24 fieldbus

Note 1 to entry: Any warning statuses are latched and need to be operated to clear them.

Note 2 to entry: Warnings are classified into three groups, communication warnings, illegal-command-related ones, and application specific ones. But concrete definitions are dependent on implementation of each field devices.

3.3 Abbreviations and symbols

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

AE	Application Entity
AL	Application Layer
A-, AL-	Application layer (as a prefix)
AP	Application Process
APDU	Application Protocol Data Unit
API	Application Process Invocation
APO	Application Process Object
APC	Application Process Context (as prefix of a protocol for type 24 fieldbus)
APC SM	Application Process Context State Machine (for type 24 fieldbus)
AR	Application Relationship
AR ASE	Application Relationship Application Service Element
AREP	Application Relationship End Point
ARPM	Application Relationship Protocol Machine (for type 24 fieldbus)
ARPM-FDCM	ARPM for Field Device Control service Master (for type 24 fieldbus)
ARPM-FDCMN	ARPM for Field Device Control service Monitor (for type 24 fieldbus)
ARPM-FDCS	ARPM for Filed Device Control service Slave (for type 24 fieldbus)
ARPM-MSG	ARPM for Message service (for type 24 fieldbus)
ASCII	American Standard code for Information Interchange
ASE	Application Service Element
ASN.1	Abstract Syntax Notation One
Cnf	Confirm primitive
DL	Data-link-layer
DL-	(as a prefix) Data Link-
DLL	Data Link Layer
DLM	Data Link-management
DLPDU	Data Link-Protocol Data Unit
DLSAP	Data Link Service Access Point
DLSDU	DL-service-data-unit
DMPM	Data Link layer Mapping Protocol Machine
FAL	Fieldbus Application Layer
FCS	Frame check sequence
FDC-	Field Device Control (as prefix of a service or a protocol for type 24 fieldbus)
FDC ASE	Field Device Control Application Service Element (for type 24 fieldbus)
FDCPM	Field Device Control Protocol Machine (for type 24 fieldbus)

FDCPM-M	Field Device Control Protocol Machine for Master (for type 24 fieldbus)
FDCPM-MN	Field Device Control Protocol Machine for Monitor (for type 24 fieldbus)
FDCPM-S	Field Device Control Protocol Machine for Slave (for type 24 fieldbus)
FIFO	First In First Out
FSPM	FAL service protocol machine
FSM-	Fieldbus System Management (as prefix of a service for type 24 fieldbus)
FSM ASE	Fieldbus System Management Application Service Element for type 24 fieldbus
HMI	Human-machine Interface
I/O	Input/output
ID	Identifier
IDL	Interface Definition Language
Ind	Indication primitive
LME	Layer Management Entity
Lsb	Least Significant Bit
Msb	Most Significant Bit
MSG	Message (as prefix of a service or a protocol for type 24 fieldbus)
MSG ASE	Message Application Service Element for type 24 fieldbus
MSGPM	Message Protocol Machine for type 24 fieldbus
MSGPM-RQ	MSGPM for Requester for type 24 fieldbus
MSGPM-RS	MSGPM for Responder for type 24 fieldbus
OSI	Open Systems Interconnect
PM	Protocol machine
PDU	Protocol Data Unit
PhL	Ph-layer
QoS	Quality of Service
RAM	Random access memory
Req	Request primitive
Rsp	Response primitive
RSP	Response PDU for FDC service (for type 24 fieldbus)
SAP	Service Access Point
SDN	Send Data with no Acknowledge
SDU	Service Data Unit
SM	State Machine
SMIB	System Management Information Base
UML	Unified Modelling Language

3.4 Conventions

3.4.1 Overview

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 two parts, its class specification, and its service specification.

The class specification defines the attributes of the class. It is assumed that the attributes are accessible from instances of the class using the Object Management ASE services specified in IEC 61158-1, 9.3. The service specification defines the services provided by the ASE.

The service model and service primitives are entirely abstract descriptions; therefore, they do not represent specifications for implementation.

3.4.2 Conventions for class definitions

Class definitions are described using templates. Each template consists of a list of attributes for the class. The general form of the template is shown below:

FAL ASE:			ASE Name
CLASS:			Class name
CLASS ID:			#
PARENT CLASS:			Parent class name
ATTRIBUTES:			
1	(o)	Key Attribute:	numeric identifier
2	(o)	Key Attribute:	Name
3	(m)	Attribute:	attribute name (values)
4	(m)	Attribute:	attribute name (values)
4.1	(s)	Attribute:	attribute name (values)
4.2	(s)	Attribute:	attribute name (values)
4.3	(s)	Attribute:	attribute name (values)
5.	(c)	Constraint:	constraint expression
5.1	(m)	Attribute:	attribute name (values)
5.2	(o)	Attribute:	attribute name (values)
6	(m)	Attribute:	attribute name (values)
6.1	(s)	Attribute:	attribute name (values)
6.2	(s)	Attribute:	attribute name (values)
SERVICES:			
1	(o)	OpsService:	service name
2	(c)	Constraint:	constraint expression
2.1	(o)	OpsService:	service name
3	(m)	MgtService:	service name

- The "FAL ASE:" entry is the name of the FAL ASE that provides the services for the class being specified.
- The "CLASS:" entry is the name of the class being specified. All objects defined using this template will be an instance of this class. The class may be specified by this document, or by a user of this document.
- The "CLASS ID:" entry is a number that identifies the class being specified. This number is unique within the FAL ASE that will provide the services for this class. When qualified by the identity of its FAL ASE, it unambiguously identifies the class within the scope of the FAL. The value "NULL" indicates that the class cannot be instantiated.
- The "PARENT CLASS:" entry is the name of the parent class for the class being specified. All attributes defined for the parent class and inherited by it are inherited for the class being defined, and therefore do not have to be redefined in the template for this class.

NOTE The parent-class "TOP" indicates that the class being defined is an initial class definition. The parent class TOP is used as a starting point from which all other classes are defined. The use of TOP is reserved for classes defined by this document.

- The "ATTRIBUTES" label indicate that the following entries are attributes defined for the class.
  - Each of the attribute entries contains a line number in column 1, a mandatory (m) / optional (o) / conditional (c) / selector (s) indicator in column 2, an attribute type label in column 3, a name or a conditional expression in column 4, and optionally a list of enumerated values in column 5. In the column following the list of values, the default value for the attribute may be specified.
  - Objects are normally identified by a numeric identifier or by an object name, or by both. In the class templates, these key attributes are defined under the key attribute.

  - The line number defines the sequence and the level of nesting of the line. Each nesting level is identified by period. Nesting is used to specify
    - fields of a structured attribute (4.1, 4.2, 4.3),
    - attributes conditional on a constraint statement (5). Attributes may be mandatory (5.1) or optional (5.2) if the constraint is true. Not all optional attributes require constraint statements as does the attribute defined in (5.2), and
    - the selection fields of a choice type attribute (6.1 and 6.2).
- The "SERVICES" label indicates that the following entries are services defined for the class.
  - An (m) in column 2 indicates that the service is mandatory for the class, while an (o) indicates that it is optional. A (c) in this column indicates that the service is conditional. When all services defined for a class are defined as optional, at least one has to be selected when an instance of the class is defined.
  - The label "OpsService" designates an operational service (1).
  - The label "MgtService" designates a management service (2).
  - The line number defines the sequence and the level of nesting of the line. Each nesting level is identified by period. Nesting within the list of services is used to specify services conditional on a constraint statement.

3.4.3 Conventions for service definitions

3.4.3.1 General

This document uses the descriptive conventions given in ISO/IEC 10731 about services and their primitives.

<name of service primitive>::= <service name>_<service-primitive-name>.<primitive-type>,

where

<primitive-type>::= request | indication | response | confirm;

<service-name> identifies ASEs providing this type of FAL services;

::= FSM | EVM | FDC | MSG | AR.

3.4.3.2 Service parameters

Service primitives are used to represent service user/service provider interactions (ISO/IEC 10731). They convey parameters which indicate information available in the user/provider interaction. In any particular interface, not all parameters need be explicitly stated.

The service specifications of this document use a tabular format to describe the component parameters of the ASE service primitives. The parameters which apply to each group of service primitives are set out in tables. Each table consists of up to five columns for

- the parameter name,
- request primitive,
- indication primitive,
- response primitive, and
- confirm primitive.

One parameter (or component of it) is listed in each row of each table. Under the appropriate service primitive columns, a code is used to specify the type of usage of the parameter on the primitive specified in the column:

M The parameter is mandatory

C The parameter is conditional

U The parameter is a user option and can be provided or not depending on dynamic usage of the service user. When not provided, a default value for the parameter is assumed.

S The parameter is a selected item.

(blank) The parameter is never present.

Some entries are further qualified by items in brackets. These may be

1) a parameter-specific constraint:

   "(=)" indicates that the parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table, and

2) an indication that some note applies to the entry:

   "(n)" indicates that the following note "n" contains additional information pertaining to the parameter and its use.

3.4.3.3 Service procedures

The procedures are defined in terms of

- the interactions between application entities through the exchange of fieldbus Application Protocol Data Units, and
- the interactions between an application layer service provider and an application layer service user in the same system through the invocation of application layer service primitives.

These procedures are applicable to instances of communication between systems that support time-constrained communications services within the FAL.

4 Concepts

The common concepts and templates used to describe the application layer service in this document are detailed in IEC 61158-1, Clause 9.

5 Data type ASE

In the communication type 24 FAL, Data type ASE complies with IEC 61158-1, Clause 10, and the other protocol-specific data types are not defined in this document.

The data types used in data fields within APDUs are defined in IEC 61158-6-24 along with the abstract syntax and transfer syntax. And other data types for attributes of object or parameters of service primitives in this document also follow with the definition of IEC 61158-6-24.

6 Communication model specifications

6.1 Type specific concepts

The application layer of the type 24 fieldbus is modelled based on the concept that is described in IEC 61158-1, Clause 5. The structure is as follows:

- the "what" is described by application layer service elements (ASE);
- the "how" is described by application layer relationships (AR).

In the type 24 FAL, the communication models consist of five types of ASE and two types of AR.

Of course, the FAL function to handle ARs is included within the ASE model as AR ASE. This document mainly describes "what" is performed by AR ASE. The protocol specification that defines "how" the communication is processed on AR is described in IEC 61158-6.

OSI system management function essentially should be represented as an entity that is independent of each layer management entity (LME) such as ALME and vertically manages all of the layers. In the type 24, however, it is integrated with the application layer management entity (ALME) to play a role as an ASE or Fieldbus System Management ASE.

6.2 Overview

The type 24 FAL models an ASE structure and their roles for the fieldbus system based on a network that consists of multiple devices among three AP types. These are C1 master, C2 master and slave (see Table 1).

To establish a communication system, one C1 master and one or more slaves are required within one network. One or more C2 masters can exist in one network. However, they need not always exist.

Furthermore, five kinds of service entities are provided for the FAL user process in the type 24 FAL. Figure 1 shows the ASE models for each AP types.

- Field Device Control ASE (FDC ASE);
- Message ASE (MSG ASE);
- Event Management ASE (EVM ASE);
- Fieldbus System Management ASE (FSM ASE);
- Application Relationship ASE (AR ASE).

Object classes that constitute the execution component of these ASE are instantiated within the sequence of AP context creation during the system boot-up. And then the ASE can execute individual services for users by communicating between corresponding objects of the peer ASEs within the network.

Among aforementioned ASEs, there are two ASEs that directly provide the communication function required by FAL user process: FDC ASE provides time critical communication; and MSG ASE can send and receive a user message that consists of large data block with variable length while it does not guarantee the transmission time. This fieldbus type can provide two types of communication services of different characteristics to FAL user by using these two types of ASEs.

AR ASE provides an end point of the application relationship (AR) to convey transmission data (APDU) when an object of the other ASE communicates with a corresponding ASE. The service definition of AR ASE is described in 6.5 along with AR model.

EVM ASE provides a service to deliver the synchronized and fixed-period signal from the network-clock counter generated by the lower layer. This signal is required as a cycle source for real-time communication by FDC ASE.

FSM ASE contributes to AP context creation and object instantiation within the other ASE.

Table 1 – AP type definition

AP type	Example device	AP Components and objects	
C1 master	Machine controller, Robot controller Inverter drive Servo drive	Specific application user process	
		F A L	FDC ASE (master objects)
			MSG ASE (a requester object, a responder object)
			AR ASE (FDCMaster-AR objects, Message-AR objects)
			EVM ASE (an event manager object)
			FSM ASE (an FSM object)
C2 master	Configuration tool, HMI Inverter drive Servo drive	Specific application user process	
		F A L	FDC ASE (monitor objects)
			MSG ASE (a requester object, a responder object)
			AR ASE (FDCMonitor-AR objects, Message-AR objects)
			EVM ASE (an event manager object)
			FSM ASE (an FSM object)
Slave, monitor slave[a]	Field devices, such as - servo drive - inverter drive - I/O device - encoder - sensor	Specific application user process	
		F A L	FDC ASE (a slave object, monitor objects[a])
			MSG ASE (responder objects)
			AR ASE (an FDCslave-AR object, FDCMonitor-AR objects[a], Message-AR objects)
			EVM ASE (an event manager object)
			FSM ASE (an FSM object)

[a] The monitor slave is a variant of slave, and it has an ability to monitor FDCservicePDU (see IEC 61158-6-24, 4.2.1) between the other slave and C1 master in addition to the ordinary slave functionality. It can be realized by adding monitor object and FDCMonitor-AR object.

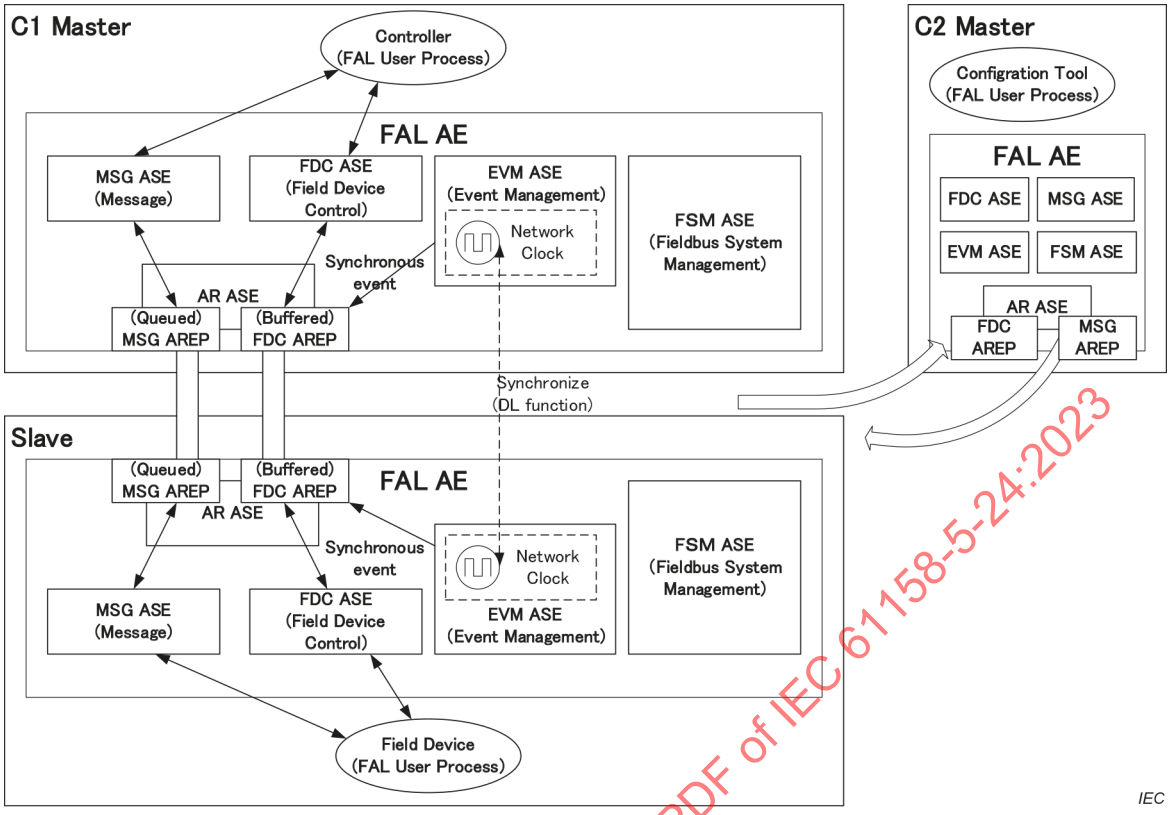

Figure 1 – FAL ASE model of Type 24

6.3 FSM ASE

6.3.1 Concepts

6.3.1.1 General

As described in 6.2, the object classes to be supported are defined for each AP type in the type 24 FAL. The maximum number of objects instantiated from the classes should be defined based on the application function and performance of the device as its product specification.

Furthermore, it is required to configure the system by selecting optional function and tuning performance with some parameters for a specific purpose of the application. For example, which object should be activated; which object should be connected to an object in the other device; how long the data length should be, what kind of transmission option should be set, and so on.

The network-system-environment operated for specific purpose or a set of configuration data as mentioned above is called as "AP-context" in this document.

A fieldbus system management (FSM) ASE is an ASE that provides services for the AP-context creation, initialization of each layer (PhL, DLL and FAL), disable control, and association management among entities and objects by using communication node address, SAPID, AREP ID and so on.

In this communication model, the following conditions shall be met when the device boots up.

- When the device boots up, all the objects of the maximum number specified in the product specification have been instantiated and the default SAPID have been given to those objects within each ASE in FAL.
- When the objects or the entities in each layer are instantiated, their statuses are equivalent to those when <s>-Reset.req has issued.

NOTE <s> refers to <service-name> described in 3.4.3.1 as well as "Ph" and "DL".

6.3.1.2 FAL common services for system management

In the type 24 FAL, all of FAL objects except ones in FSM ASE support the common services for system management by the FSM ASE. These services are <s>-Reset, <s>-Open and <s>-Enable.

- <s>-Reset is a service to disable and deactivate the object by reset the state and the attribute values of the object to the initial condition just after boot-up.
- <s>-Open is a service to initialize the state and the attribute values of the object to the specified value during the process for establishing the targeted AP-context.

NOTE Even under this condition, the main function of the object is continuously disabled. This is a mechanism of the interlock to prevent unintended malfunction of the system during the initialization process.

- <s>-Enable is a service to enable and activate the main function of the object.

Because the parameters passed in each Open and Enable service differ in each ASE, refer to the subclauses of each ASE for the detailed specification of the services.

6.3.1.3 Service overview

FSM ASE provides a set of services to initialize the communication environment. See Table 2. It provides the following services to the FAL user process:

- initialization of each layer or ASE in FAL;
- configuring the communication parameter and profile of each layer or ASE.

Only one FSM ASE object exists in each communication node.

Table 2 – Support list of service for each class of FSM ASE

Service	Class	Request	indication	response	conform
FSM-Reset	FieldbusSystemManager	M			
FSM-GetStatus	FieldbusSystemManager	M			M
FSM-SetContext	FieldbusSystemManager	M			M
FSM-GetContext	FieldbusSystemManager	M			M
FSM-Start	FieldbusSystemManager	M			M

6.3.2 FieldbusSystemManager class specifications

6.3.2.1 FieldbusSystemManager class definition

The FSM class definition is shown below.

FAL ASE:		Fieldbus System Management ASE		
CLASS:		FieldbusSystemManager		
CLASS ID:		not used		
PARENT CLASS:		TOP		
ATTRIBUTES:				
1	(o)	Key Attribute:	Numeric Identifier	-- common FAL attribute
2	(o)	Key Attribute:	Name	-- common FAL attribute
3	(o)	Attribute:	User Description	-- common FAL attribute
4	(o)	Attribute:	Object Revision	-- common FAL attribute
4.1	(o)	Attribute:	Major Revision	-- common FAL attribute
4.2	(o)	Attribute:	Minor Revision	-- common FAL attribute
5	(m)	Attribute:	SAPID	
6	(m)	Attribute:	State	-- State# of SM as APCSM
7	(m)	Attribute	APType	

8	(m)	Attribute	CONTEXT-DATA	-- depending on implementation
SERVICES:				
1	(m)	MgtService:	FSM-Reset	
2	(m)	OpsService:	FSM-GetStatus	
3	(m)	OpsService	FSM-SetContext	
4	(m)	OpsService	FSM-GetContext	
5	(m)	OpsService	FSM-Start	

6.3.2.2 FieldbusSystemManager class attribute definition

6.3.2.2.1 Numeric Identifier

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.3.2.2.2 Name

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.3.2.2.3 User Description

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.3.2.2.4 Object Revision

This attribute one of the common FAL attributes. See IEC 61158-1, 9.7.

6.3.2.2.5 SAPID

This attribute contains a code that a user specifies and identifies this object to get the service. It is unique within the system and allocated by system management at the instantiation of the object.

6.3.2.2.6 State

This attribute contains a state number of a state machine APC SM (see IEC 61158-6-24, Clause 7), which is the main function of this object.

6.3.2.2.7 APType

This attribute contains a code of the AP type (see 6.2) the device belongs to,

- 1: C1 master,
- 2: C2 master, and
- 3: slave.

6.3.2.2.8 CONTEXT-DATA

This attribute contains a various system configuration data that are inputted by a user, configuration information detected in the network directly, system condition at run-time, and so on. The detailed specification and data structure depend on the implementation.

6.3.2.3 FieldbusSystemManager class service definition

6.3.2.3.1 FSM-Reset

This service is used to disable the PhL, DLL, and the all objects of ASEs in the device through each <s>-Reset service, and to reset the state of the APCSM.

Table 3 shows the parameter of the service.

Table 3 – FSM-Reset

Parameter name	Req
Argument	

Argument

In this service there are no specific parameters.

6.3.2.3.2 FSM-GetStatus

This service is used to get the status of the system, error, and etc. The kind of status that can be acquired depends on implementation.

Table 4 shows the parameter of the service.

Table 4 – FSM-GetStatus

Parameter name	Req	Cnf
Argument	M	
INFO-ID	M	
Result (+)		S
Service status		M
INFO-ID		M
INFO-DATA		M
Result (−)		S
Service status		M

Argument
The argument contains the parameters of the service request.

INFO-ID
This parameter is the local identifier to specify the desired status data. The contents of the status that can be acquired depend on the real system implementation.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

INFO-ID
This parameter is the local identifier for the desired status. The kind of the status that can be acquired depends on the implementation.

INFO-DATA
This parameter is the status of the system, error, and so on.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates the following error:

– service not supported.

6.3.2.3.3 FSM-SetContext

This service is used to set the CONTEXT-DATA to the attributes of FieldbusSystemManager.

The information of the communication parameter etc. is included in CONTEXT-DATA and delivered to all the objects of ASEs in the device through each <s>-Open service. The lower layers are also initialized with this information.

The detail specification of the information depends on the real system implementation.

Table 5 shows the parameter of the service.

Table 5 – FSM-SetContext

Parameter name	Req	Cnf
Argument	M	
CONTEXT-DATA	M	
Result (+)		S
Service status		M
CONTEXT-DATA		M
Result (−)		S
Service status		M

Argument
The argument contains the parameters of the service request.

CONTEXT-DATA
This parameter contains the device type or model, the communication mode, the system configuration, the communication cycle, the transmission speed, the communication data length, the timer parameter, and the lower layer parameter, and etc. The detail specification of the information depends on the real system implementation.

NOTE It is also called "System Management Information Base (SMIB)".

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

CONTEXT-DATA
This parameter is read back of the result of the set CONTEXT-DATA.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates the following error:

– Service not supported.

6.3.2.3.4 FSM-GetContext

This service is used to get the CONTEXT-DATA from the attributes of Fieldbus System Manager.

Table 6 shows the parameter of the service.

Table 6 – FSM-GetContext

Parameter name	Req	Cnf
Argument		
Result (+)		S
Service status		M
CONTEXT-DATA		M
Result (−)		S
Service status		M

Argument
In this service there are no specific parameters for request.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

CONTEXT-DATA
This parameter contains the device type or model, the communication mode, the system configuration, the communication cycle, the transmission speed, the communication data length, the timer parameter, and the lower layer parameter, and etc.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates the following error:

– Service not supported.

6.3.2.3.5 FSM-Start

This service is used to activate every ASE in the node, and the lower layer.

All objects of ASEs in the device are enabled through each <s>-Enable service. The lower layers are also activated with appropriate service, which depends on the real system implementation.

Table 7 shows the parameter of the service.

Table 7 – FSM-Start

Parameter name	Req	Cnf
Argument		

Argument
In this service there are no specific parameters.

6.4 FAL ASEs

6.4.1 Field Device Control ASE

6.4.1.1 Service overview

Field Device Control (FDC) ASE provides the following services for the user to control the field devices (see Table 8):

- to send a control command and receive the response with a set of commands defined as the field device profile;

NOTE As for the device profile, see 3.2.21 and IEC 61158-6-24, Annex A.

- to read the device ID information, to configure the field device profile, and to read and write device specific parameters for the targeted field device;
- to notifies the communication cycle event to the user;
- to monitor the corresponding device with a watchdog timer (WDT) counter mechanism or error detection mechanism in the synchronous communication mode;
- to transmit a device alarm and its clear-control with the header field of the FDCServicePDU.

Table 8 – Support list of service for each class of FDC ASE

Service	Class	request	indication	response	conform
FDC-Reset	Master	M			
	Slave	M			
	Monitor	M			
FDC-Open	Master	M			M
	Slave	M			M
	Monitor	M			M
FDC-Enable	Master	M			
	Slave	M			
	Monitor	M			
FDC-Connect	Master	O			O
	Slave		O	O	
	Monitor				

Service	Class	request	indication	response	conform
FDC-SyncSet	Master	O			O
	Slave		O	O	
	Monitor				
FDC-Disconnect	Master	O			
	Slave		O	O	
	Monitor				
FDC-ResumeCycle	Master	M			
	Slave	M			
	Monitor				
FDC-ComCycle	Master		M		
	Slave		M		
	Monitor				
FDC-Command	Master	M			M
	Slave		M	M	
	Monitor				
FDC-DataExchange	Master	M			M
	Slave	M			M
	Monitor				
FDC-GetCMD	Master				
	Slave				
	Monitor	M			M
FDC-GetRSP	Master				
	Slave				
	Monitor	M			M

6.4.1.2 Master class specifications

6.4.1.2.1 Master class definition

The Master class definition is shown below.

FAL ASE: Field_Device_Control ASE
CLASS: Master
CLASS ID: not used
PARENT CLASS: TOP
ATTRIBUTES:

1	(o)	Key Attribute:	Numeric Identifier	-- common FAL attribute
2	(o)	Key Attribute:	Name	-- common FAL attribute
3	(o)	Attribute:	User Description	-- common FAL attribute
4	(o)	Attribute:	Object Revision	-- common FAL attribute
4.1	(o)	Attribute:	Major Revision	-- common FAL attribute
4.2	(o)	Attribute:	Minor Revision	-- common FAL attribute
5	(m)	Attribute:	SAPID	
6	(m)	Attribute:	State	-- State# of PM as FDCPM-M
6.1	(m)	Attribute:	Major state	
6.2	(m)	Attribute:	Minor state	
7	(m)	Attribute:	AREP ID	-- Related AR SAPID
8	(m)	Attribute:	TransMode	-- Cyclic / EventDriven
9	(m)	Attribute:	ProtocolVersion	
10	(m)	Attribute:	SyncMode	-- Sync / Async mode
11	(m)	Attribute:	DTMode	-- Dual / Single Transfer mode
12	(m)	Attribute:	SubCMDMode	-- Support or not

13	(m)	Attribute:	ComTime	-- Scale factor of transmission cycle
14	(m)	Attribute:	DevProfileType	
15	(m)	Attribute:	LastCMD-SDU	
16	(m)	Attribute:	LastRSP-SDU	
17	(m)	Attribute:	WDT	
17.1	(m)	Attribute:	LastSN	
17.2	(m)	Attribute:	LastMN	
18	(m)	Attribute:	RWDT	
18.1	(m)	Attribute:	LastRSN	
18.2	(m)	Attribute:	LastRMN	

SERVICES:

1	(m)	MgtService:	FDC-Reset
2	(m)	MgtService:	FDC-Open
3	(m)	MgtService:	FDC-Enable
4	(m)	OpsService:	FDC-Connect
5	(m)	OpsService:	FDC-SyncSet
6	(m)	OpsService:	FDC-Disconnect
7	(m)	OpsService:	FDC-ResumeCycle
8	(m)	OpsService:	FDC-ComCycle
9	(m)	OpsService:	FDC-Command
10	(m)	OpsService:	FDC-DataExchange

6.4.1.2.2 Master class attribute specifications

6.4.1.2.2.1 Numeric Identifier

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.1.2.2.2 Name

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.1.2.2.3 User Description

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.1.2.2.4 Object Revision

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.1.2.2.5 SAPID

This attribute contains a code that a user specifies and identifies this object to get the service. It is unique within the system and allocated by system management at the instantiation of the object.

6.4.1.2.2.6 State

This attribute contains a state number of the protocol machine (PM) FDCPM-M (see IEC 61158-6-24, 8.2.4), which is the main function of this object.

- **major state:**
  state number of main PM;
- **minor state:**
  state number of sub-machine.

6.4.1.2.2.7 AREP ID

This attribute contains a SAPID of AR ASE, which this object stores to use AR services.

It is specified by FSM ASE as a parameter of FDC-Open request.

6.4.1.2.2.8 TransMode

This attribute contains a transmission mode of DLL:

- 0: cyclic mode;
- 1: event-driven mode.

It is specified by FSM ASE as a parameter of FDC-Enable request.

6.4.1.2.2.9 ProtocolVersion

This attribute contains the protocol version of the type 24 fieldbus.

It is obtained from a SDU parameter within Connect service sequence and then to be stored.

6.4.1.2.2.10 SyncMode

This attribute contains the communication mode:

- 0: asynchronous mode;
- 1: synchronous mode.

It is obtained from a SDU parameter within Connect service sequence and then to be stored.

6.4.1.2.2.11 DTMode

This attribute contains the transfer mode:

- 0: single transfer mode;
- 1: dual transfer mode.

It is obtained from a SDU parameter within Connect service sequence and then to be stored.

6.4.1.2.2.12 SubCMDMode

This attribute contains a selection status of support option for the subcmd-PDU field in the FDCServicePDU (see IEC 61158-6-24, 4.2.2.2):

- 0: not supported;
- 1: supported.

It is obtained from a SDU parameter within Connect service sequence and then to be stored.

6.4.1.2.2.13 ComTime

This attribute contains a scale factor that specifies the period of the communication cycle in the form of a multiple of the period of transmission cycle.

It is obtained from a SDU parameter within Connect service sequence and then to be stored.

6.4.1.2.2.14 DevProfileType

This attribute contains the device profile code of slave device that specifies a used command set.

It is obtained from a SDU parameter within Connect service sequence and then to be stored.

6.4.1.2.2.15 LastCMD-SDU

This attribute stores the command SDU or PDU to send, gotten from the user.

6.4.1.2.2.16 LastRSP-SDU

This attribute stores the latest response SDU or PDU received from the corresponding slave object.

6.4.1.2.2.17 WDT

This attribute stores the last setting value in the wdt field of the sent command PDU in the synchronous communication state.

6.4.1.2.2.18 RWDT

This attribute stores the last set value in the rwdt field of the received response PDU in the synchronous communication state.

6.4.1.2.3 Master class service specifications

6.4.1.2.3.1 FDC-Reset

The FDC-Reset service is used to reset and keep disabling a master object.

Table 9 shows the parameter of the service.

Table 9 – FDC-Reset for master class

Parameter name	Req
Argument	

Argument
In this service, there are no specific parameters.

6.4.1.2.3.2 FDC-Open

The FDC-Open service is used to initialize a master object.

Table 10 shows the parameter of the service.

Table 10 – FDC-Open for master class

Parameter name	Req	Cnf
Argument	M	
AREPID	M	
Result (+)		S
Service status		M
Result (−)		S
Service status		M

Argument
The argument contains the parameters of the service request.

AREPID
This parameter is the local identifier for a related AREP.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported;
– Already opened;
– Responder busy.

6.4.1.2.3.3 FDC-Enable

The FDC-Enable service is used to make the master object active.

Table 11 shows the parameter of the service.

Table 11 – FDC-Enable for master class

Parameter name	Req	Cnf
Argument	M	
TransmissionMode	M	

Argument
The argument contains the parameters of the service request.

TransmissionMode
This argument informs the transmission mode of the DLL:

– cyclic mode;
– event driven mode.

6.4.1.2.3.4 FDC-Connect

The FDC-Connect service is used to establish connection with the slave and start a communication cycle.

Table 12 shows the parameter of the service.

Table 12 – FDC-Connect for master class

Parameter name	Req	Cnf
Argument	M	
Update	M	
CONNECT-CMD-SDU	M	
Result (+)		S
Service status		M
Communication status		M
Progress status		M
RSP-SDU		M
Result (−)		S
Service status		M

Argument
The argument contains the parameters of the service request.

Update
This parameter informs the update of SDU:

- Yes (update);
- No (not update).

CONNECT-CMD-SDU
The parameter contains the SDU to be sent, when the parameter "Update" is set as "YES". This parameter should be referenced from the _CONNECT-CMD-PDU data type defined in IEC 61158-6-24.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

Communication status
This parameter indicates the communication status in the received RSP-PDU.

Progress status
This parameter indicates the progress status of command processing in the corresponding slave:

- BUSY: the command in processing, and no more command acceptable;
- READY: no command in processing, so a new command acceptable.

RSP-SDU
The parameter contains the received PDU.

NOTE Refer to the RSP-PDU data type defined in IEC 61158-6-24.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported;
– Not opened;
– Not enabled.

6.4.1.2.3.5 FDC-SyncSet

The FDC-SyncSet service is used to send SYNC_SET command to the slave to make the state transition from the asynchronous communication state to the synchronous communication state.

Table 13 shows the parameter of the service.

Table 13 – FDC-SyncSet for master class

Parameter name	Req	Cnf
Argument	M	
Update	M	
SYNC_SET-CMD-SDU	M	
Result (+)		S
Service status		M
Communication status		M
Progress status		M
RSP-SDU		M
Result (−)		S
Service status		M

Argument
The argument contains the parameters of the service request.

Update
This parameter informs the update of SDU:

– Yes (update);
– No (not update).

SYNC_SET-CMD-SDU
The parameter contains the SDU to be sent, when the parameter "Update" is set as "YES".

NOTE Refer to the _SYNC_SET-CMD-PDU data type defined in IEC 61158-6-24.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

Communication status
This parameter indicates the communication status in the received RSP-PDU.

Progress status

This parameter indicates the progress status of command processing in the corresponding slave:

– BUSY: the command in processing, and no more command acceptable;
– READY: no command in processing, so a new command acceptable.

RSP-SDU
The parameter contains the received PDU.

NOTE Refer to the _RSP-PDU data type defined in IEC 61158-6-24.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported;
– Not opened;
– Not enabled.

6.4.1.2.3.6 FDC-Disconnect

The FDC-Disconnect service is used to release the communication connection.

Table 14 shows the parameter of the service.

Table 14 – FDC-Disconnect for master class

Parameter name	Req
Argument	M
Update	M
DISCONNECT-CMD-SDU	M

Argument
The argument contains the parameters of the service request.

Update
This parameter informs the update of SDU:

- Yes (update);
- No (not update).

DISCONNECT-CMD-SDU
The parameter contains the SDU to be sent, when the parameter "Update" is set as "YES".

NOTE Refer to the _DISCONNECT-CMD-PDU data type defined in IEC 61158-6-24.

6.4.1.2.3.7 FDC-ResumeCycle

The FDC-ResumeCycle service is used to refresh related attributes and to resume the communication after released the connection.

Table 15 shows the parameter of the service.

Table 15 – FDC-ResumeCycle for master class

Parameter name	Req
Argument	

Argument
In this service there are no specific parameters.

6.4.1.2.3.8 FDC-ComCycle

The FDC-ComCycle service is used to signal an event generated by AR ASE every communication cycle to the user.

Table 16 shows the parameter of the service.

Table 16 – FDC-ComCycle for master class

Parameter name	Ind
Argument	
NetworkClock	U

Argument
The argument contains the parameters of the service indication.

NetworkClock

This parameter notifies the counter value synchronized with all the nodes.

NOTE The range of NetworkClock is

0 to 65 535 for fixed-width time slot type (see IEC 61158-4-24, 4.3.2.1), and

Unsinged32 for configurable time slot type (see IEC 61158-4-24, 4.3.2.2).

6.4.1.2.3.9 FDC-Command

The FDC-Command service is used to send a command to the slave and to receive the corresponding response.

Table 17 shows the parameter of the service.

Table 17 – FDC-Command for master class

Parameter name	Req	Cnf
Argument	M	
Update	M	
CMD-SDU	M	
Result (+)		S
Service status		M
Communication status		M
Progress status		M
RSP-SDU		M
Result (−)		S
Service status		M

Argument
The argument contains the parameters of the service request.

Update
This parameter informs the update of SDU:

– Yes (update);
– No (not update).

CMD-SDU
The parameter contains the SDU to be sent, when the parameter "Update" is set as "YES".

NOTE Refer to the _CMD-PDU data type defined in IEC 61158-6-24.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

Communication status
This parameter indicates the communication status in the received RSP-PDU.

Progress status
This parameter indicates the progress status of command processing in the corresponding slave:

– BUSY: the command in processing, and no more command acceptable;
– READY: no command in processing, so a new command acceptable.

RSP-SDU
The parameter contains the received PDU.

NOTE Refer to the _RSP-PDU data type defined in IEC 61158-6-24.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported;
– Not opened;
– Not enabled.

6.4.1.2.3.10 FDC-DataExchange

The FDC-DataExchange service is used to get the response data from AR ASE and put the command data to it.

Table 18 shows the parameter of the service.

Table 18 – FDC-DataExchange for master class

Parameter name	Req	Cnf
Argument	M	
RSP-SDU	M	
Result		S
CMD-SDU		M

Argument
The argument contains the parameters of the service request.

RSP-SDU
The parameter contains the received PDU.

NOTE Refer to the _RSP-PDU data type defined in IEC 61158-6-24.

Result
This selection type parameter indicates that the service request succeeded.

CMD-SDU
The parameter contains the PDU to be sent.

NOTE Refer to the _CMD-PDU data type defined in IEC 61158-6-24.

6.4.1.3 Slave class specifications

6.4.1.3.1 Slave class definition

The Slave class definition is shown below.

FAL ASE:		Field_Device_Control ASE		
CLASS:		Slave		
CLASS ID:		not used		
PARENT CLASS:		TOP		
ATTRIBUTES:				
1	(o)	Key Attribute:	Numeric Identifier	-- common FAL attribute
2	(o)	Key Attribute:	Name	-- common FAL attribute
3	(o)	Attribute:	User Description	-- common FAL attribute
4	(o)	Attribute:	Object Revision	-- common FAL attribute
4.1	(o)	Attribute:	Major Revision	-- common FAL attribute
4.2	(o)	Attribute	Minor Revision	-- common FAL attribute
5	(m)	Attribute:	SAPID	
6	(m)	Attribute:	State	-- State# of PM as FDCPM-S
6.1	(m)	Attribute:	Major state	
6.2	(m)	Attribute:	Minor state	
7	(m)	Attribute:	AREP ID	-- Related AR SAPID
8	(m)	Attribute:	TransMode	-- Cyclic / EventDriven
9	(m)	Attribute:	ProtocolVersion	
10	(m)	Attribute:	SyncMode	-- Sync / Async mode
11	(m)	Attribute:	DTMode	-- Dual / Single Transfer mode
12	(m)	Attribute:	SubCMDMode	-- Support or not
13	(m)	Attribute:	ComTime	-- Scale factor of transmission cycle
14	(m)	Attribute:	DevProfileType	
15	(m)	Attribute:	LastCMD-SDU	
16	(m)	Attribute:	LastRSP-SDU	
17	(m)	Attribute:	WDT	
17.1	(m)	Attribute:	LastSN	
17.2	(m)	Attribute:	LastMN	
18	(m)	Attribute:	RWDT	
18.1	(m)	Attribute:	LastRSN	
18.2	(m)	Attribute:	LastRMN	
SERVICES:				
1	(m)	MgtService	FDC-Reset	
2	(m)	MgtService	FDC-Open	
3	(m)	MgtService	FDC-Enable	
4	(m)	OpsService:	FDC-Connect	
5	(m)	OpsService:	FDC-SyncSet	
6	(m)	OpsService:	FDC-Disconnect	
7	(m)	OpsService:	FDC-ResumeCycle	
8	(m)	OpsService:	FDC-ComCycle	
9	(m)	OpsService:	FDC-Command	
10	(m)	OpsService:	FDC-DataExchange	

6.4.1.3.2 Slave class attribute specifications

6.4.1.3.2.1 Numeric Identifier

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.1.3.2.2 Name

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.1.3.2.3 User Description

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.1.3.2.4 Object Revision

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.1.3.2.5 SAPID

This attribute contains a code that a user specifies and identifies this object to get the service. It is unique within the system and allocated by system management at the instantiation of the object.

6.4.1.3.2.6 State

This attribute contains a state number of protocol machine (PM) FDCPM-S (see IEC 61158-6-24, 8.2.5), which is the main function of this object.

- **major state:**
  state number of main PM;
- **minor state:**
  state number of sub-machine.

6.4.1.3.2.7 AREP ID

This attribute contains a SAPID of AR ASE, which this object stores to use AR services.

It is specified by FSM ASE as a parameter of FDC-Open request.

6.4.1.3.2.8 TransMode

This attribute contains a transmission mode of DLL:

- 0: cyclic mode;
- 1: event-driven mode.

It is specified by FSM ASE as a parameter of FDC-Enable request.

6.4.1.3.2.9 ProtocolVersion

This attribute contains the protocol version of the type 24 fieldbus.

It is obtained from a SDU parameter within Connect service sequence and then to be stored.

6.4.1.3.2.10 SyncMode

This attribute contains the communication mode:

- 0: asynchronous mode;
- 1: synchronous mode.

It is obtained from a SDU parameter within Connect service sequence and then to be stored.

6.4.1.3.2.11 DTMode

This attribute contains the transfer mode:

- 0: single transfer mode;
- 1: dual transfer mode.

It is obtained from a SDU parameter within Connect service sequence and then to be stored.

6.4.1.3.2.12 SubCMDMode

This attribute contains a selection status of support option for the subcmd-PDU field in the FDCServicePDU (see IEC 61158-6-24, 4.2.2.2):

- 0: not supported;
- 1: supported.

It is obtained from a SDU parameter within Connect service sequence and then to be stored.

6.4.1.3.2.13 ComTime

This attribute contains a scale factor that specifies the period of the communication cycle in the form of a multiple of the period of transmission cycle.

It is obtained from a SDU parameter within Connect service sequence and then to be stored.

6.4.1.3.2.14 DevProfileType

This attribute contains the device profile code of this slave device that specifies a used command set.

It is obtained from a SDU parameter within Connect service sequence and then to be stored.

6.4.1.3.2.15 LastCMD-SDU

This attribute stores the command SDU or PDU received from the corresponding master object.

6.4.1.3.2.16 LastRSP-SDU

This attribute stores the latest response SDU or PDU to send, gotten from the user.

6.4.1.3.2.17 WDT

This attribute stores the last set value in the wdt field of the received command PDU in the synchronous communication state.

6.4.1.3.2.18 RWDT

This attribute stores the last setting value in the rwdt field of the sent response PDU in the synchronous communication state.

6.4.1.3.3 Slave class service specifications

6.4.1.3.3.1 FDC-Reset

The FDC-Reset service is used to reset and keep disabling a slave object.

Table 19 shows the parameter of the service.

Table 19 – FDC-Reset for slave class

Parameter name	Req
Argument	

Argument
In this service there are no specific parameters.

6.4.1.3.3.2 FDC-Open

The FDC-Open service is used to initialize a slave object.

Table 20 shows the parameter of the service.

Table 20 – FDC-Open for slave class

Parameter name	Req	Cnf
Argument	M	
AREPID	M	
Result (+)		S
Service status		M
Result (−)		S
Service status		M

Argument
The argument contains the parameters of the service request.

AREPID
This parameter is the local identifier for a related AREP.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported;
– Already opened;
– Responder busy.

6.4.1.3.3.3 FDC-Enable

The FDC-Enable service is used to make the slave object active.

Table 21 shows the parameter of the service.

Table 21 – FDC-Enable for slave class

Parameter name	Req	Cnf
Argument	M	
TransmissionMode	M	

Argument
The argument contains the parameters of the service request.

TransmissionMode
This argument informs the transmission mode of the DLL:

– cyclic mode,
– event driven mode.

6.4.1.3.3.4 FDC-Connect

The FDC-Connect service is used to establish connection with the master and start a communication cycle.

Table 22 shows the parameter of the service.

Table 22 – FDC-Connect for slave class

Parameter name	Ind	Rsp
Argument	M	
Update	M	
CONNECT-CMD-SDU	M	
Result (+)		S
Service status		M
Progress status		M
RSP-SDU		M
Result (−)		S
Service status		M
Progress status		M
RSP-SDU		M

Argument
The argument contains the parameters of the service indication.

Update
This parameter indicates the update of SDU:

– Yes (update);
– No (not update).

CONNECT-CMD-SDU
The parameter contains the received PDU, when the parameter "Update" is set as "YES".

NOTE Refer to the _CONNECT-CMD-PDU data type defined in IEC 61158-6-24.

Result (+)
This selection type parameter informs that the service request succeeded from the user.

Service status
This parameter informs success from the user.

Progress status
This parameter informs the progress status of command processing in the user:

– BUSY: the command in processing, and no more command acceptable;
– READY: no command in processing, so a new command acceptable.

RSP-SDU
The parameter contains the SDU to be sent.

NOTE Refer to the _RSP-PDU data type defined in IEC 61158-6-24.

Result (−)
This selection type parameter indicates that the service request failed from the user.

Service status
This parameter informs command fail from the user.

Progress status
This parameter informs the progress status of command processing in the user:

- BUSY: the command in processing, and no more command acceptable;
- READY: no command in processing, so a new command acceptable.

RSP-SDU
The parameter contains the SDU to be sent.

NOTE Refer to the _RSP-PDU data type defined in IEC 61158-6-24.

6.4.1.3.3.5 FDC-SyncSet

The FDC-SyncSet service is used to receive SYNC_SET command from the master to make the state transition from the asynchronous communication state to the synchronous communication state.

Table 23 shows the parameter of the service.

Table 23 – FDC-SyncSet for slave class

Parameter name	Ind	Rsp
Argument	M	
Update	M	
SYNC_SET-CMD-SDU	M	
Result (+)		S
Service status		M
Progress status		M
RSP-SDU		M
Result (−)		S
Service status		M
Progress status		M
RSP-SDU		M

Argument
The argument contains the parameters of the service indication.

Update
This parameter indicates the update of SDU:

- Yes (update);
- No (not update).

SYNC_SET-CMD-SDU
The parameter contains the received PDU, when the parameter "Update" is set as "YES".

NOTE Refer to the _SYNC_SET-CMD-PDU data type defined in IEC 61158-6-24.

Result (+)
This selection type parameter informs that the service request succeeded from the user.

Service status
This parameter informs success from the user.

Progress status
This parameter informs the progress status of command processing in the user:

- BUSY: the command in processing, and no more command acceptable;
- READY: no command in processing, so a new command acceptable.

RSP-SDU
The parameter contains the SDU to be sent.

NOTE Refer to the _RSP-PDU data type defined in IEC 61158-6-24.

Result (−)
This selection type parameter indicates that the service request failed from the user.

Service status
This parameter informs command fail from the user.

Progress status
This parameter informs the progress status of command processing in the user:

- BUSY: the command in processing, and no more command acceptable;
- READY: no command in processing, so a new command acceptable.

RSP-SDU
The parameter contains the SDU to be sent.

NOTE Refer to the _RSP-PDU data type defined in IEC 61158-6-24.

6.4.1.3.3.6 FDC-Disconnect

The FDC-Disconnect service is used to release the communication connection.

Table 24 shows the parameter of the service.

Table 24 – FDC-Disconnect for slave class

Parameter name	Ind	Rsp
Argument	M	
DISCONNECT-SDU	M	
Result (+)		M
Service status		M
Progress status		M
RSP-SDU		M

Argument
The argument contains the parameters of the service indication.

Update
This parameter indicates the update of SDU:

– Yes (update);
– No (not update).

DISCONNECT-CMD-SDU
The parameter contains the received PDU, when the parameter "Update" is set as "YES".

NOTE Refer to the _DISCONNECT-CMD-PDU data type defined in IEC 61158-6-24.

Result (+)
This selection type parameter always informs that the service request succeeded from the user.

Service status
This parameter always informs success from the user.

Progress status
This parameter informs the progress status of command processing in the user:

BUSY: the command in processing, and no more command acceptable;
READY: no command in processing, so a new command acceptable.

RSP-SDU
The parameter contains the SDU to be sent.

NOTE Refer to the _RSP-PDU data type defined in IEC 61158-6-24.

6.4.1.3.3.7 FDC-ResumeCycle

The FDC-ResumeCycle service is used to refresh related attributes and to resume the communication after released the connection.

Table 25 shows the parameter of the service.

Table 25 – FDC-ResumeCycle for slave class

Parameter name	Req
Argument	

Argument
In this service, there are no specific parameters.

6.4.1.3.3.8 FDC-ComCycle

The FDC-ComCycle service is used to signal an event generated by AR ASE every communication cycle to the user.

Table 26 shows the parameter of the service.

Table 26 – FDC-ComCycle for slave class

Parameter name	Ind
Argument	
NetworkClock	U

Argument
The argument contains the parameters of the service indication.

NetworkClock
This parameter notifies the counter value synchronized with all the nodes.

6.4.1.3.3.9 FDC-Command

The FDC-Command service is used to receive a command from the master and to send the corresponding response.

Table 27 shows the parameter of the service.

Table 27 – FDC-Command for slave class

Parameter name	Ind	Rsp
Argument	M	
Update	M	
CMD-SDU	M	
Result (+)		S
Service status		M
Progress status		M
RSP-SDU		M
Result (−)		S
Service status		M
Progress status		M
RSP-SDU		M

Argument
The argument contains the parameters of the service indication.

Update
This parameter indicates the update of SDU:

- Yes (update);
- No (not update).

CMD-SDU
The parameter contains the received PDU, when the parameter "Update" is set as "YES".

NOTE Refer to the _CMD-PDU data type defined in IEC 61158-6-24.

Result (+)
This selection type parameter informs that the service request succeeded from the user.

Service status
This parameter informs success from the user.

Progress status
This parameter informs the progress status of command processing in the user:

- BUSY: the command in processing, and no more command acceptable;
- READY: no command in processing, so a new command acceptable.

RSP-SDU
The parameter contains the SDU to be sent.

NOTE Refer to the _RSP-PDU data type defined in IEC 61158-6-24.

Result (−)
This selection type parameter indicates that the service request failed from the user.

Service status
This parameter informs command fail from the user.

Progress status
This parameter informs the progress status of command processing in the user:

- BUSY: the command in processing, and no more command acceptable;
- READY: no command in processing, so a new command acceptable.

RSP-SDU
The parameter contains the SDU to be sent.

NOTE Refer to the _RSP-PDU data type defined in IEC 61158-6-24.

6.4.1.3.3.10 FDC-DataExchange

The FDC-DataExchange service is used to get the command data from AR ASE and to put the response data to it.

Table 28 shows the parameter of the service.

Table 28 – FDC-Command for slave class

Parameter name	Req	Cnf
Argument	M	
CMD-SDU	M	
Result		M
RSP-SDU		M

Argument
The argument contains the parameters of the service request.

CMD-SDU
The parameter contains the received PDU.

NOTE Refer to the _CMD-PDU data type defined in IEC 61158-6-24.

Result
This selection type parameter indicates that the service request succeeded.

RSP-SDU
The parameter contains the PDU to be sent.

NOTE Refer to the _RSP-PDU data type defined in IEC 61158-6-24.

6.4.1.4 Monitor class specification

6.4.1.4.1 Monitor class definition

The Monitor class definition is shown below.

FAL ASE:		Field_Device_Control ASE		
CLASS:		Monitor		
CLASS ID:		not used		
PARENT CLASS:		TOP		
ATTRIBUTES:				
1	(o)	Key Attribute:	Numeric Identifier	-- common FAL attribute
2	(o)	Key Attribute:	Name	-- common FAL attribute
3	(o)	Attribute:	User Description	-- common FAL attribute
4	(o)	Attribute:	Object Revision	-- common FAL attribute
4.1	(o)	Attribute:	Major Revision	-- common FAL attribute
4.2	(o)	Attribute	Minor Revision	-- common FAL attribute
5	(m)	Attribute:	SAPID	
6	(m)	Attribute:	State	-- State# of PM (FDCPM-M)
6.1	(m)	Attribute:	Major state	
6.2	(m)	Attribute:	Minor state	
7	(m)	Attribute:	AREP ID List	-- Related AR-SAPID list
8	(m)	Attribute:	TransMode	-- Cyclic / EventDriven
SERVICES:				
1	(m)	MgtService	FDC-Reset	
2	(m)	MgtService	FDC-Open	
3	(m)	MgtService	FDC-Enable	
11	(m)	OpsService:	FDC-GetCMD	
12	(m)	OpsService:	FDC-GetRSP	

6.4.1.4.2 Monitor class attribute specifications

6.4.1.4.2.1 Numeric Identifier

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.1.4.2.2 Name

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.1.4.2.3 User Description

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.1.4.2.4 Object Revision

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.1.4.2.5 SAPID

This attribute contains a code that a user specifies and identifies this object to get the service. It is unique within the system and allocated by system management at the instantiation of the object.

6.4.1.4.2.6 State

This attribute contains a state number of protocol machine (PM) FDCPM-MN (see IEC 61158-6-24, 8.2.6), which is the main function of this object.

- **major state:**
  state number of main PM;
- **minor state:**
  state number of sub-machine.

6.4.1.4.2.7 AREP ID List

This attribute contains a list of SAPIDs of AR ASE, which this object stores to use AR services.

It is specified by FSM ASE as a parameter of FDC-Open request.

6.4.1.4.2.8 TransMode

This attribute contains a transmission mode of DLL:

- 0: cyclic mode;
- 1: event-driven mode.

It is specified by FSM ASE as a parameter of FDC-Enable request.

6.4.1.4.3 Monitor class service specifications

6.4.1.4.3.1 FDC-Reset

The FDC-Reset service is used to reset and keep disabling a monitor object.

Table 29 shows the parameter of the service.

Table 29 – FDC-Reset for monitor class

Parameter name	Req
Argument	

Argument
In this service there are no specific parameters.

6.4.1.4.3.2 FDC-Open

The FDC-Open service is used to initialize a monitor object.

Table 30 shows the parameter of the service.

Table 30 – FDC-Open for monitor class

Parameter name	Req	Cnf
Argument	M	
AREPIDList	M	
Result (+)		S
Service status		M
Result (−)		S
Service status		M

Argument
The argument contains the parameters of the service request.

AREPIDList
This parameter is the list of the accessible local identifier for a related AREP.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported;
– Already opened;
– Responder busy.

6.4.1.4.3.3 FDC-Enable

The FDC-Enable service is used to make the monitor object active.

Table 31 shows the parameter of the service.

Table 31 – FDC-Enable for monitor class

Parameter name	Req	Cnf
Argument	M	
TransmissionMode	M	

Argument
The argument contains the parameters of the service request.

TransmissionMode
This argument informs the transmission mode of the DLL:

cyclic mode;

event driven mode.

6.4.1.4.3.4 FDC-GetCMD

The FDC-GetCMD service is used to read out a received CMD_PDU for the slave with the remote APID that is specified in the parameter of the primitive.

Table 32 shows the parameter of the service.

Table 32 – FDC-GetCMD for monitor class

Parameter name	Req	Cnf
Argument	M	
APID	M	
Result (+)		S
Service status		M
Communication mode		M
CMD-SDU		M
Result (−)		S
Service status		M

Argument
The argument contains the parameters of the service request.

APID
This parameter specifies the remote AP ID of the target slave from which PDU is read out.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

Communication status
This parameter indicates the communication status in the monitored CMD-PDU.

CMD-SDU
The parameter contains the received PDU.

NOTE Refer to the _CMD-PDU data type defined in IEC 61158-6-24.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported;
– Not opened;
– Not enabled.

6.4.1.4.3.5 FDC-GetRSP

The FDC-GetRSP service is used to read out a received RSP_PDU for the slave with the remote APID that is specified in the parameter of the primitive.

Table 33 shows the parameter of the service.

Table 33 – FDC-GetRSP for monitor class

Parameter name	Req	Cnf
Argument	M	
APID	M	
Result (+)		S
Service status		M
Communication status		M
RSP-SDU		M
Result (−)		S
Service status		M

Argument
The argument contains the parameters of the service request.

APID
This parameter specifies the remote AP ID of the target slave from which PDU is read out.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

Communication status
This parameter indicates the communication status in the monitored RSP-PDU.

RSP-SDU
The parameter contains the received PDU.

NOTE Refer to the _RSP-PDU data type defined in IEC 61158-6-24.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported;
– Not opened;
– Not enabled.

6.4.2 Message ASE

6.4.2.1 Service overview

Message ASE provides a set of services (see Table 34) to convey the variable length message irregularly without so severe restriction on the response time.

In this service, the requester sends the message request PDU, and the responder that receives it replies the message response PDU. The responder need not always reply the PDU according to the content of the Message request PDU.

The following services are provided for the FAL user process that does the sending and receiving message.

- User message service: Sending the request from the requester to the responder, and receiving the response from the responder to the requester;
- One way message service: Sending the request from the requester to the responder without the response from responder;
- Abort service: Cancelling the transaction.

Table 34 – Support list of service for each class of Message ASE

Service	Class	request	indication	response	conform
MSG-Reset	Requester	M			
	Responder	M			
MSG-Open	Requester	M			M
	Responder	M			M
MSG-Enable	Requester	M			
	Responder	M			
MSG-UserMessage	Requester	M			M
	Responder		M	M	
MSG-OnewayMessage	Requester	M			M
	Responder		M		
MSG-AbortTransmission	Requester	M			
	Responder	M			

6.4.2.2 Requester class specifications

6.4.2.2.1 Requester class definition

The Requester class definition is shown below.

FAL ASE:		Message ASE		
CLASS:		Requester		
CLASS ID:		not used		
PARENT CLASS:		TOP		
ATTRIBUTES:				
1	(o)	Key Attribute:	Numeric Identifier	-- common FAL attribute
2	(o)	Key Attribute:	Name	-- common FAL attribute
3	(o)	Attribute:	User Description	-- common FAL attribute
4	(o)	Attribute:	Object Revision	-- common FAL attribute
4.1	(o)	Attribute:	Major Revision	-- common FAL attribute
4.2	(o)	Attribute:	Minor Revision	-- common FAL attribute
5	(m)	Attribute:	SAPID	
6	(m)	Attribute:	State	-- State# of PM as MSGPM-RQ
7	(m)	Attribute:	AREP ID	-- Related AR SAPID
8	(m)	Attribute:	Transaction	
8.1	(m)	Attribute:	TID	-- Transaction ID
8.2	(o)	Attribute:	SPID	-- Source process ID
8.3	(o)	Attribute:	DPID	-- Destination process ID
8.4	(m)	Attribute:	Length	-- Length of SDU
8.5	(o)	Attribute	SDU	-- Copy of Requesting SDU
SERVICES:				
1	(m)	MgtService:	MSG-Reset	
2	(m)	MgtService:	MSG-Open	
3	(m)	MgtService:	MSG-Enable	
4	(m)	OpsService:	MSG-UserMessage	
5	(m)	OpsService:	MSG-OnewayMessage	
6	(m)	OpsService	MSG-AbortTransaction	

6.4.2.2.2 Requester class attribute specifications

6.4.2.2.2.1 Numeric Identifier

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.2.2.2.2 Name

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.2.2.2.3 User Description

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.2.2.2.4 Object Revision

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.2.2.2.5 SAPID

This attribute contains a code that a user specifies and identifies this object to get the service. It is unique within the system and allocated by system management at the instantiation of the object.

6.4.2.2.2.6 State

This attribute contains a state number of protocol machine (PM) MSGPM-RQ (see IEC 61158-6-24, 8.3.2), which is the main function of this object.

- **major state:**
  state number of main PM;
- **minor state:**
  state number of sub-machine.

6.4.2.2.2.7 AREP ID

This attribute contains a SAPID of AR ASE, which this object stores to use AR services.

It is specified by FSM ASE as a parameter of MSG-Open request.

6.4.2.2.2.8 Transaction

This attribute stores the parameters of the requesting primitive and a SDU to manage the transaction.

NOTE As for TID, SPID, DPID Length and SDU, refer to the MSG-UserMessage Service Specifications. See 6.4.2.2.3.4.

6.4.2.2.3 Requester class service specifications

6.4.2.2.3.1 MSG-Reset

The MSG-Reset service is used to reset and keep disabling a requester object.

Table 35 shows the parameter of the service.

Table 35 – MSG-Reset for requester class

Parameter name	Req
Argument	

Argument
In this service, there are no specific parameters.

6.4.2.2.3.2 MSG-Open

The MSG-Open service is used to initialize a requester object.

Table 36 shows the parameter of the service.

Table 36 – MSG-Open for requester class

Parameter name	Req	Cnf
Argument	M	
AREPID	M	
Result (+)		S
Service status		M
Result (−)		S
Service status		M

Argument
The argument contains the parameters of the service request.

AREPID
This parameter is the accessible local identifier for a related AREP.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

- Service not supported;
- Already opened;
- Responder busy.

6.4.2.2.3.3 MSG-Enable

The MSG-Enable service is used to make the requester object active.

Table 37 shows the parameter of the service.

Table 37 – MSG-Enable for requester class

Parameter name	Req	Cnf
Argument		

Argument
In this service, there are no specific parameters of the service request.

6.4.2.2.3.4 MSG-UserMessage

This service is used to send the MSGReq-SDU and to receive the MSGRsp-SDU.

Table 38 shows the parameter of the service.

Table 38 – MSG-UserMessage for requester class

Parameter name	Req	Cnf
Argument	M	
TID	U	
SPID	U	
DPID	M	
Length	M	
MSGReq-SDU	M	
Result (+)		S
Service status		M
TID		U
SPID		U
Length		M
MSGRsp-SDU		M
Result (−)		S
Service status		M
TID		U
SPID		U

Argument
The argument contains the parameters of the service request.

TID
This parameter is the local identifier for the desired transaction. To do so, the FAL user can specify any unique number.

SPID
This parameter is the local identifier for the source AP or the FAL user of the requester object.

DPID
This parameter is the remote identifier for the destination AP or the corresponding remote FAL user.

Length
This parameter contains the octet length of the MSGReq-SDU.

– Allowed range: 4 to 16 384 octets.

MSGReq-SDU
The parameter contains the request message from the FAL user. This parameter should consist of the number of octets indicated in the "Length" parameter of the request.

NOTE Refer to the _MSGREQ-PDU data types defined in IEC 61158-6-24.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

TID
This parameter is the corresponding local identifier attached when requested the transaction.

SPID
This parameter is the local identifier for the source AP or the requesting user.

Length
This parameter contains the octet length of the MSGRsp-SDU.

– Allowed values: 4 to 16 384.

MSGRsp-SDU
The parameter contains the response message from the remote FAL user. This parameter should consist of the number of octets indicated in the "Length" parameter of the confirmation.

NOTE Refer to the _MSGRSP-PDU data type defined in IEC 61158-6-24.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported;
– Not opened;
– Not enabled.

TID
This parameter is the corresponding local identifier attached when requested the transaction.

SPID
This parameter is the local identifier for the source AP or the requesting user.

6.4.2.2.3.5 MSG-OnewayMessage

This service is used to send the MSGReq-SDU that is not required to response.

Table 39 shows the parameter of the service.

Table 39 – MSG-OnewayMessage for requester class

Parameter name	Req	Cnf
Argument	M	
TID	U	
SPID	U	
DPID	M	
Length	M	
MSGReq-SDU	M	
Result (+)		S
Service status		M
TID		U
SPID		U
Result (−)		S
Service status		M
TID		U
SPID		U

Argument
The argument contains the parameters of the service request.

TID
This parameter is the local identifier for the desired transaction. To do so, the FAL user can specify any unique number.

SPID
This parameter is the local identifier for the source AP or the FAL user of the requester object.

DPID
This parameter is the remote identifier for the destination AP or the corresponding remote FAL user.

Length
This parameter contains the octet length of the MSGReq-SDU.

– Allowed range: 4 to 16 384 octets.

MSGReq-SDU
The parameter contains the request message from the FAL user. This parameter should consist of the number of octets indicated in the "Length" parameter of the request.

NOTE Refer to the _MSGREQ-PDU data types defined in IEC 61158-6-24.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

TID
This parameter is the corresponding local identifier attached when requested the transaction.

SPID
This parameter is the local identifier for the source AP or the requesting user.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported;
– Not opened;
– Not enabled.

TID
This parameter is the corresponding local identifier attached when requested the transaction.

SPID
This parameter is the local identifier for the source AP or the requesting user.

6.4.2.2.3.6 MSG-AbortTransaction

This service is used to abort the message transaction.

Table 40 shows the parameter of the service.

Table 40 – MSG-AbortTransaction for requester class

Parameter name	Req	Cnf
Argument	M	
TID	U	

Argument
The argument contains the parameters of the service request.

TID
This parameter is the local identifier to specify the desired transaction. If TID isn't specified, all the transaction or unsolved requests shall be aborted.

6.4.2.3 Responder class specifications

6.4.2.3.1 Responder class definition

The Responder class definition is shown below.

FAL ASE:		Message ASE		
CLASS:		Responder		
CLASS ID:		not used		
PARENT CLASS:		TOP		
ATTRIBUTES:				
1	(o)	Key Attribute:	Numeric Identifier	-- common FAL attribute
2	(o)	Key Attribute:	Name	-- common FAL attribute
3	(o)	Attribute:	User Description	-- common FAL attribute
4	(o)	Attribute:	Object Revision	-- common FAL attribute
4.1	(o)	Attribute:	Major Revision	-- common FAL attribute
4.2	(o)	Attribute	Minor Revision	-- common FAL attribute
5	(m)	Attribute:	SAPID	
6	(m)	Attribute:	State	-- State# of PM as MSGPM-RS
7	(m)	Attribute:	AREP ID	-- Related AR SAPID
8	(m)	Attribute:	Transaction	
9.1	(m)	Attribute:	TID	-- Transaction ID
9.2	(o)	Attribute:	SPID	-- Source process ID
9.3	(o)	Attribute:	DPID	-- Destination process ID
9.4	(m)	Attribute:	Length	-- Length of SDU
9.5	(o)	Attribute	SDU	-- Copy of Requesting SDU
SERVICES:				
1	(m)	MgtService:	MSG-Reset	
2	(m)	MgtService:	MSG-Open	
3	(m)	MgtService:	MSG-Enable	
4	(m)	OpsService:	MSG-UserMessage	
5	(m)	OpsService:	MSG-OnewayMessage	
6	(m)	OpsService	MSG-AbortTransaction	

6.4.2.3.2 Responder class attribute specifications

6.4.2.3.2.1 Numeric Identifier

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.2.3.2.2 Name

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.2.3.2.3 User Description

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.2.3.2.4 Object Revision

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.2.3.2.5 SAPID

This attribute contains a code that a user specifies and identifies this object to get the service. It is unique within the system and allocated by system management at the instantiation of the object.

6.4.2.3.2.6 State

This attribute contains a state number of protocol machine (PM) MSGPM-RS (see IEC 61158-6-24, 8.3.3), which is the main function of this object.

- **major state:**
  state number of main PM;
- **minor state:**
  state number of sub-machine.

6.4.2.3.2.7 AREP ID

This attribute contains a SAPID of AR ASE, which this object stores to use AR services.

It is specified by FSM ASE as a parameter of MSG-Open request.

6.4.2.3.2.8 Transaction

This attribute stores the parameters of the requesting primitive and a SDU to manage the transaction.

NOTE As for TID, SPID, DPID Length and SDU, refer to the MSG-UserMessage Service Specifications. See 6.4.2.3.3.4.

6.4.2.3.3 Responder class service specifications

6.4.2.3.3.1 MSG-Reset

The MSG-Reset service is used to reset and keep disabling a responder object.

Table 41 shows the parameter of the service.

Table 41 – MSG-Reset for responder class

Parameter name	Req
Argument	

Argument
In this service there are no specific parameters.

6.4.2.3.3.2 MSG-Open

The MSG-Open service is used to initialize a responder object.

Table 42 shows the parameter of the service.

Table 42 – MSG-Open for responder class

Parameter name	Req	Cnf
Argument	M	
AREPID	M	
Result (+)		S
Service status		M
Result (−)		S
Service status		M

Argument
The argument contains the parameters of the service request.

AREPID
This parameter is the accessible local identifier for a related AREP.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported;
– Already opened;
– Responder busy.

6.4.2.3.3.3 MSG-Enable

The MSG-Enable service is used to make the responder object active.

Table 43 shows the parameter of the service.

Table 43 – MSG-Enable for responder class

Parameter name	Req	Cnf
Argument		

Argument
In this service there are no specific parameters of the service request.

6.4.2.3.3.4 MSG-UserMessage

This service is used to receive the MSGReq-SDU and to send the MSGRsp-SDU.

Table 44 shows the parameter of the service.

Table 44 – MSG-UserMessage for responder class

Parameter name	Ind	Rsp
Argument	M	
TID	U	
SPID	U	
DPID	U	
Length	M	
MSGReq-SDU	M	
Result (+)		S
Service status		M
TID		U
DPID		U
Length		M
MSGRsp-SDU		M
Result (−)		S
Service status		M
TID		U
DPID		U

Argument
The argument contains the parameters of the service indication.

TID
This parameter is the local identifier for the desired transaction. To do so, the responder object can specify any unique number.

SPID
This parameter is the remote identifier for the source AP or the FAL user of the requester object.

DPID
This parameter is the local identifier for the destination AP in a received request message.

Length
This parameter contains the octet length of the received MSGReq-SDU.

– Allowed range: 4 to 16 384 octets.

MSGReq-SDU
The parameter contains the request message from the corresponding FAL user. This parameter should consist of the number of octets indicated in the "Length" parameter.

NOTE Refer to the _MSGREQ-PDU data types defined in IEC 61158-6-24.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

TID
This parameter is the corresponding local identifier attached when received the transaction.

DPID
This parameter is the local identifier for the destination AP or the responder user.

Length
This parameter contains the octet length of the MSGRsp-SDU.

– Allowed Values: 4 to 16 384.

MSGRsp-SDU
The parameter contains the response message from the FAL user. This parameter should consist of the number of octets indicated in the "Length" parameter of the response.

NOTE Refer to the _MSGRSP-PDU data type defined in IEC 61158-6-24.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported;
– Not opened;
– Not enabled.

TID
This parameter is the corresponding local identifier attached when requested the transaction.

DPID
This parameter is the local identifier for the destination AP or the responder user.

6.4.2.3.3.5 MSG-OnewayMessage

This service is used to receive the MSGReq-SDU that is not required to response.

Table 45 shows the parameter of the service.

Table 45 – MSG-OnewayMessage for responder class

Parameter name	Ind
Argument	M
TID	U
SPID	U
DPID	U
Length	M
MSGReq-SDU	M

Argument
The argument contains the parameters of the service indication.

TID
This parameter is the local identifier for the desired transaction. To do so, the responder object can specify any unique number.

SPID
This parameter is the remote identifier for the source AP or the FAL user of the requester object.

DPID
This parameter is the local identifier for the destination AP in a received request message.

Length
This parameter contains the octet length of the received MSGReq-SDU.

– Allowed range: 4 to 16 384 octets.

MSGReq-SDU
The parameter contains the request message from the corresponding FAL user. This parameter should consist of the number of octets indicated in the "Length" parameter.

NOTE Refer to the _MSGREQ-PDU data types defined in IEC 61158-6-24.

6.4.2.3.3.6 MSG-AbortTransaction

This service is used to abort the message transaction.

Table 46 shows the parameter of the service.

Table 46 – MSG-AbortTransaction for responder class

Parameter name	Req	Cnf
Argument	M	
TID	M	

Argument
The argument contains the parameters of the service request.

TID
This parameter is the local identifier to specify the desired transaction. If TID isn't specified, all the transaction or unsolved requests shall be aborted.

6.4.3 Event Management ASE

6.4.3.1 Service overview

Event Management ASE provides the following services for the FAL user process that supports a cyclic communication. See Table 47.

- Raising the cyclic event at every transmission cycle;
- Reading the network clock.

This event is a trigger of the FAL user process processing that supports the fixed cycle communication.

Only one Event Management object exists in each communication node.

Table 47 – Support list of service for each class of Event Management ASE

Service	Class	request	indication	response	conform
EVM-Reset	EventManager	M			
EVM-Enable	EventManager	M			
EVM-SyncEvent	EventManager		M		
EVM-ReadNetClock	EventManager	U			U

6.4.3.2 EventManager class specification

6.4.3.2.1 EventManager class definition

The EventManager class definition is shown below.

FAL ASE:		EventManagement ASE		
CLASS:		EventManager		
CLASS ID:		not used		
PARENT CLASS:		TOP		
ATTRIBUTES:				
1	(o)	Key Attribute:	Numeric Identifier	-- common FAL attribute
2	(o)	Key Attribute:	Name	-- common FAL attribute
3	(o)	Attribute:	User Description	-- common FAL attribute
4	(o)	Attribute:	Object Revision	-- common FAL attribute
4.1	(o)	Attribute:	Major Revision	-- common FAL attribute
4.2	(o)	Attribute:	Minor Revision	-- common FAL attribute
5	(m)	Attribute:	SAPID	
6	(m)	Attribute:	AREP ID List	-- Related AR SAPID List
7	(o)	Attribute:	NetworkClock	
SERVICES:				
1	(m)	MgtService:	EVM-Reset	
2	(m)	MgtService:	EVM-Enable	
3	(m)	OpsService:	EVM-SyncEvent	
4	(o)	OpsService:	EVM-ReadNetClock	

6.4.3.2.2 EventManager Class attribute definition

6.4.3.2.2.1 Numeric Identifier

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.3.2.2.2 Name

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.3.2.2.3 User Description

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.3.2.2.4 Object Revision

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.4.3.2.2.5 SAPID

This attribute contains a code that a user specifies and identifies this object to get the service. It is unique within the system and allocated by system management at the instantiation of the object.

6.4.3.2.2.6 AREP ID List

This attribute contains a list of SAPIDs of AR ASE, which this object stores to use AR services.

It is specified by FSM ASE as a parameter of MSG-Open request.

6.4.3.2.2.7 NetworkClock

This attribute contains a copied value of synchronized counter with every transmission cycle event.

6.4.3.2.3 EventManager class service definition

6.4.3.2.3.1 EVM-Reset

The EVM-Reset service is used to reset and keep disabling an EventManager object.

Table 48 shows the parameter of the service.

Table 48 – EVM-Reset

Parameter name	Req
Argument	

Argument
In this service there are no specific parameters.

6.4.3.2.3.2 EVM-Enable

The EVM-Enable service is used to make the EventManager object active.

Table 49 shows the parameter of the service.

Table 49 – EVM-Enable

Parameter name	Req	Cnf
Argument		

Argument
In this service there are no specific parameters of the service request.

6.4.3.2.3.3 EVM-SyncEvent

This service is used to indicate the transmission cycle to other ASEs.

Table 50 shows the parameter of the service.

Table 50 – EVM-SyncEvent

Parameter name	Ind
Argument	
NetClock	U

Argument
In this service there are no specific parameters of the service indication.

NetClock
This parameter indicates the network clock value.

6.4.3.2.3.4 EVM-ReadNetClock

This service is used to read the network clock.

Table 51 shows the parameter of the service.

Table 51 – EVM-ReadNetClock

Parameter name	Req	Cnf
Argument		
Result (+)		S
Service status		M
NetClock		M
Result (−)		S
Service status		M

Argument
In this service, there are no specific parameters of the service request.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

NetClock
This parameter indicates the network clock value.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported;
– Not enabled.

6.5 FAL ARs

6.5.1 AR model

6.5.1.1 Overview

In the type 24 FAL, two types of FAL service elements are defined, field device control (FDC) ASE and message (MSG) ASE. Corresponding to the two ASEs, two kinds of AREP are provided:

- Field device control (FDC) AREP;
- Message (MSG) AREP.

AR ASE is an ASE that manages AR and AREP, and exchanges APDU with the corresponding FAL entity through the AREP.

FDC AREPs are handled by three types of classes in the ASE:

- FDC Master AR class;
- FDC Slave AR class;
- FDC Monitor AR class.

MSG AREPs are handled by one type of classes in the ASE:

- Message AR class.

Table 52 shows AR ASE service by each class.

Table 52 – Support list of service for each class of AR ASE

Service	Class	request	indication	response	conform
AR-Reset	FDCMaster-AR	M			
	FDCSlave-AR	M			
	FDCMonitor-AR	M			
	Message-AR	M			
AR-Open	FDCMaster-AR	M			M
	FDCSlave-AR	M			M
	FDCMonitor-AR	M			M
	Message-AR	M			M
AR-Enable	FDCMaster-AR	M			
	FDCSlave-AR	M			
	FDCMonitor-AR	M			
	Message-AR	M			
AR-CycleEvent	FDCMaster-AR		M		
	FDCSlave-AR		M		
	FDCMonitor-AR				
	Message-AR				
AR-StartComCycle	FDCMaster-AR	M			
	FDCSlave-AR	M			
	FDCMonitor-AR				
	Message-AR				

Service	Class	request	indication	response	conform
AR-ResetCycle	FDCMaster-AR	M			
	FDCSlave-AR	M			
	FDCMonitor-AR				
	Message-AR				
AR-SendCommand	FDCMaster-AR	M			M
	FDCSlave-AR		M	M	
	FDCMonitor-AR				
	Message-AR				
AR-GetCMD	FDCMaster-AR				
	FDCSlave-AR				
	FDCMonitor-AR	M			M
	Message-AR				
AR-GetRSP	FDCMaster-AR				
	FDCSlave-AR				
	FDCMonitor-AR	M			M
	Message-AR				
AR-SendMessage	FDCMaster-AR				
	FDCSlave-AR				
	FDCMonitor-AR				
	Message-AR	M			M
AR-ReceiveMessage	FDCMaster-AR				
	FDCSlave-AR				
	FDCMonitor-AR				
	Message-AR	M			M
AR-AbortMessage	FDCMaster-AR				
	FDCSlave-AR				
	FDCMonitor-AR				
	Message-AR	M			

6.5.1.2 AR model for field device control service

AR for field device control service (FDC AR) model consists of a basic unit based on the connection type of the requester – responder relationship between FDC master and FDC slave (see Figure 2).

NOTE This kind of logical configurations of AR within the network is sometimes represented with formula (1:1)×n (n refers to the number of slaves).

Furthermore, a monitor-slave, which has both a slave function and a monitor function, and a C2 master can monitor PDUs between the requester and responder. In this case, the relationship between the monitoring-side and monitored-side can be considered as a publisher-subscriber relation of push type. Also, a C1 master and a C2 master can be considered as a requester-responder relationship.

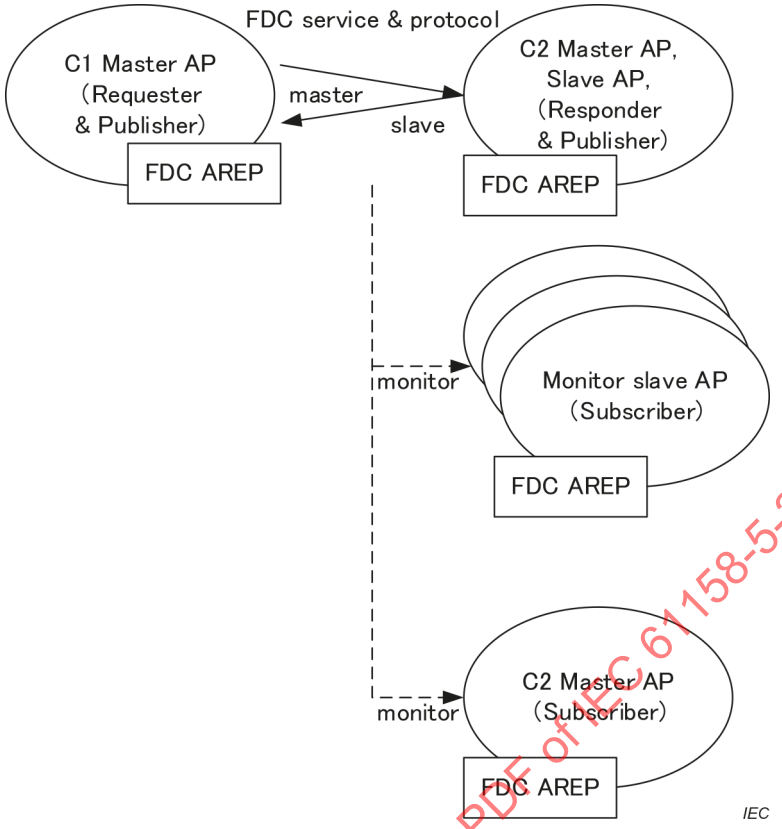

Figure 2 – AR model for field device control service

6.5.1.3 AR model for message service

AR for message service (MSG AR) model is a requester-responder relationship of a connectionless type (see Figure 3). MSG AR supports the pseudo-confirmed type service request as well as the confirmed type service request. In the case of the pseudo-confirmed service request, after sending a request, no response comes back and a transmit completion confirm is sent back within the requester.

One requester can communicate two or more responder by switching the destination because MSG AR is an AR of connectionless type.

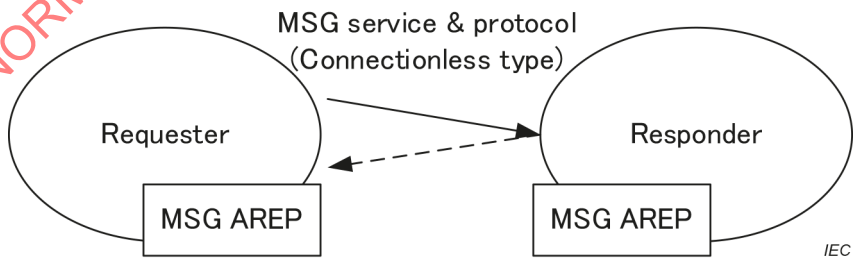

Figure 3 – AR model for message service

As shown in Figure 4, a C1 master AP and a C2 master AP implement one AREP for a requester and a responder respectively. A slave AP can implement two AREPs for a responder at the maximum.

NOTE The above constraints on the number of AREPs implemented in each AP are caused by the limitation to the number of message channel in the lower layer and are not a necessary condition required by the application layer.

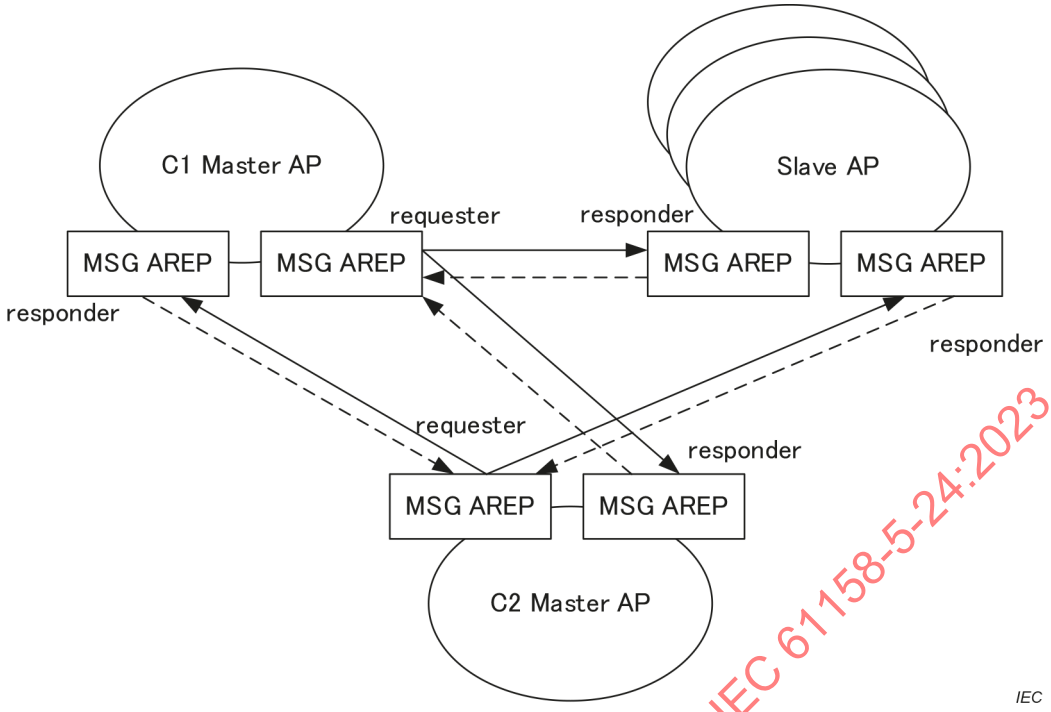

Figure 4 – MSG ARs between each APs

6.5.2 FDC AREP

6.5.2.1 FDC Master AR class

6.5.2.1.1 FDC Master AR class definition

The FDCMaster-AR class definition is shown below.

FAL ASE:		Application Relationship ASE		
CLASS:		FDCMaster-AR		
CLASS ID:		not used		
PARENT CLASS:		TOP		
ATTRIBUTES:				
1	(o)	Key Attribute:	Numeric Identifier	-- common FAL attribute
2	(o)	Key Attribute:	Name	-- common FAL attribute
3	(o)	Attribute:	User Description	-- common FAL attribute
4	(o)	Attribute:	Object Revision	-- common FAL attribute
4.1	(o)	Attribute:	Major Revision	-- common FAL attribute
4.2	(o)	Attribute:	Minor Revision	-- common FAL attribute
5	(m)	Attribute:	SAPID	
6	(m)	Attribute:	State	-- State# of ARPM-FDCM
6.1	(m)	Attribute:	Major State	
6.2	(m)	Attribute:	Minor State	
7	(m)	Attribute:	DLSAPID	-- Related DLSAPID
8	(m)	Attribute:	FDCSAPID	-- Related FDC SAPID
9	(m)	Attribute:	TransMode	-- Cyclic / EventDriven
10	(m)	Attribute:	DTMode	-- Dual / Single Transfer mode
11	(m)	Attribute:	ComTime	-- Scale factor of transmission cycle
12	(m)	Attribute:	CycleScaleCounter	
SERVICES:				
1	(m)	MgtService:	AR-Reset	
2	(m)	MgtService:	AR-Open	
3	(m)	MgtService:	AR-Enable	
4	(m)	OpsService:	AR-CycleEvent	
5	(m)	OpsService:	AR-StartComCycle	
6	(m)	OpsService	AR-ResetCycle	

7	(o)	OpsService	AR-SendCommand

6.5.2.1.2 FDC Master AR class attribute specifications

6.5.2.1.2.1 Numeric Identifier

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.5.2.1.2.2 Name

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.5.2.1.2.3 User Description

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.5.2.1.2.4 Object Revision

This attribute is one of the common FAL attributes. See IEC 61158-1, 9.7.

6.5.2.1.2.5 SAPID

This attribute contains a code that a user specifies and identifies this object to get the service. It is unique within the system and allocated by system management at the instantiation of the object.

6.5.2.1.2.6 State

This attribute contains a state number of protocol machine (PM) ARPM-FDCM (see IEC 61158-6-24, 9.2.2), which is the main function of this object.

- **major state:**
  state number of main PM;
- **minor state:**
  state number of sub-machine.

6.5.2.1.2.7 DLSAPID

This attribute contains a SAPID of DLL, which this object stores to use DL services.

It is specified by FSM ASE as a parameter of AR-Open request.

6.5.2.1.2.8 FDCSAPID

This attribute contains a SAPID of the related FDC object, which this object stores to use FDC services.

It is specified by FSM ASE as a parameter of AR-Open request.

6.5.2.1.2.9 TransMode

This attribute contains a transmission mode of DLL:

- 0: cyclic mode;
- 1: event-driven mode.

It is specified by FSM ASE as a parameter of AR-Enable request.

6.5.2.1.2.10 DTMode

This attribute contains the transfer mode:

- 0: single transfer mode;
- 1: dual transfer mode.

It is obtained from FDC ASE as a parameter of AR-StartComCycle and then to be stored.

6.5.2.1.2.11 ComTime

This attribute contains a scale factor that specifies the period of the communication cycle in the form of a multiple of the period of transmission cycle.

It is obtained from FDC ASE as a parameter of AR-StartComCycle and then to be stored.

6.5.2.1.2.12 CycleScaleCounter

This attribute contains a counter that is counted at each transmission cycle signal from 0 to ($ComTime$−1) to manage the progress of communication cycle.

6.5.2.1.3 FDC Master AR class service specification

6.5.2.1.3.1 AR-Reset

The AR-Reset service is used to reset and keep disabling an FDC-Master-AR object.

Table 53 shows the parameter of the service.

Table 53 – AR-Reset for FDC Master AR class

Parameter name	Req
Argument	

Argument
In this service there are no specific parameters.

6.5.2.1.3.2 AR-Open

The AR-Open service is used to initialize an FDC-Master-AR object.

Table 54 shows the parameter of the service.

Table 54 – AR-Open for FDC Master AR class

Parameter name	Req	Cnf
Argument	M	
DLSAPID	M	
FDCSAPID	M	
Result (+)		S
Service status		M
Result (−)		S
Service status		M

Argument
The argument contains the parameters of the service request.

DLSAPID
This parameter is the accessible local identifier for a related DLSAP.

FDCSAPID
This parameter is the accessible local identifier for a related FDCSAP.

Result (+)
This selection type parameter indicates that the service request succeeded.

Service status
This parameter indicates success.

Result (−)
This selection type parameter indicates that the service request failed.

Service status
This parameter indicates an error among the following choices:

– Service not supported,
– Already opened.

6.5.2.1.3.3 AR-Enable

The AR-Enable service is used to make the FDC-Master-AR object active. In this process, the transmission mode of the lower layer is notified by a parameter.

Table 55 shows the parameter of the service.

Table 55 – AR-Enable for FDC Master AR class

Parameter name	Req	Cnf
Argument	M	
TransmissionMode	M	

Argument
The argument contains the parameters of the service request.

TransmissionMode
This argument informs the transmission mode of the DLL:

– cyclic mode;
– event driven mode.

6.5.2.1.3.4 AR-CycleEvent

This service is used to signal an event generated in AR ASE every communication cycle to the AR user.

Table 56 shows the parameter of the service.

Table 56 – AR-CycleEvent for FDC Master AR class

Parameter name	Ind
Argument	
NetworkClock	U

Argument
The argument contains the parameters of the service indication.

NetworkClock
This parameter notifies the counter value synchronized with all the nodes.

NOTE The range of NetworkClock is:

0 to 65 535 for fixed-width time slot type (see IEC 61158-4-24, 4.3.2.1), and

Unsinged32 for configurable time slot type (see IEC 61158-4-24, 4.3.2.2).

6.5.2.1.3.5 AR-StartComCycle

This service is used to start a communication cycle of AR ASE just after the connection has been established.

Table 57 shows the parameter of the service.

Table 57 – AR-StartComCycle for FDC Master AR class

Parameter name	Req
Argument	M
ComTime	M
DTMode	M
CMDForm	M