



BSI Standards Publication

Industrial communication networks — Fieldbus specifications

Part 5-27: Application layer service definition — Type 27 elements

National foreword

This British Standard is the UK implementation of EN IEC 61158-5-27:2023. It is identical to IEC 61158-5-27:2023.

The UK participation in its preparation was entrusted to Technical Committee GEL/65, Measurement and control.

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

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Part 5-27: Application layer service definition - Type 27 elements
(IEC 61158-5-27:2023)

Réseau de communication industriels - Spécifications des
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couche application - Eléments de type 27
(IEC 61158-5-27:2023)

Industrielle Kommunikationsnetze - Feldbusse - Teil 5-27:
Application layer service definition (Anwendungsschicht) -
Type 27-Elemente
(IEC 61158-5-27:2023)

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European foreword

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2026-04-11

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

IEC 61158-2 NOTE Approved as EN 61158-2

IEC 61158-6 (series) NOTE Approved as EN 61158-6 (series)

IEC 61784-1 (series) NOTE Approved as EN IEC 61784-1 (series)¹

IEC 61784-2 (series) NOTE Approved as EN IEC 61784-2 (series)²

¹ To be published. Stage at the time of publication: FprEN IEC 61784-1-X:2023.

² To be published. Stage at the time of publication: FprEN IEC 61784-2-X:2023.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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

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

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

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61158-1	2023	Industrial communication networks - Fieldbus specifications - Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series	EN IEC 61158-1	2023
IEC 61158-6-27	2023	Industrial communication networks - Fieldbus Specifications Part 6-27: Application layer protocol specification - Type 27 elements	EN IEC 61158-6-27	2023
ISO/IEC 7498-1	-	Information technology - Open Systems Interconnection - Basic reference model: The basic model	-	-
ISO/IEC 8824-1	-	Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation	-	-
ISO/IEC 9545	-	Information technology - Open Systems Interconnection - Application layer structure	-	-
ISO/IEC 10731	-	Information technology - Open Systems Interconnection - Basic Reference Model - Conventions for the definition of OSI services	-	-
IEEE Std 802	2014	IEEE Standard for Local and metropolitan area networks: Overview and Architecture	-	-
IEEE Std 802.1AS	-	IEEE standard for Local and metropolitan area networks - Timing and Synchronization for Time-Sensitive Applications	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 5-27: Application layer service definition – Type 27 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 61158-5-27 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation. It is an International Standard.

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

Draft	Report on voting
65C/1205/FDIS	65C/1234/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, 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 5-27: Application layer service definition – Type 27 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 part of IEC 61158 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 27 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 document 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 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 document, 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 document.

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 61158-6-27:2023, *Industrial communication networks – Fieldbus specifications – Part 6-27: Application layer protocol specification – Type 27 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): 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*

IEEE Std 802-2014, *IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture*

IEEE Std 802.1AS, *IEEE Standard for Local and Metropolitan Area Networks – Timing and Synchronization for Time-Sensitive Applications*

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 terminology 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:

- abstract syntax;
- application-entity;
- application process;
- application protocol data unit;
- application-process-invocation;
- (N)-facility;
- (N)-function;
- correspondent-(N)-entities;
- presentation context;
- real system;
- 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:

- application-association;
- application-context;
- application-entity-invocation;
- application-entity-type;
- 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:

- 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:

- OSI-service-primitive; primitive;
- OSI-service-provider; provider;
- 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 27 fieldbus

Note 1 to entry: Any alarm statuses are latched and need some operations 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 device.

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: Details are given in 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, etc. 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 27 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 27 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 61158-6-27, 4.4 and Annex A).

3.2.6**asynchronous communication**

state or a way of communication for the FDC service of the Type 27 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 27 FAL, or the device implementing that AP type

Note 1 to entry: Only one C1 master exists in a network of the Type 27 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 27 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 27 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 27 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 27 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 27 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 27 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 27 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 27 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 27 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 27 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 27 FAL

3.2.27**master**

class or its instance object of FDC application service element (ASE) that plays a role of a command requester for the Type 27 FAL

3.2.28**message service****MSG service**

communication service that handles the variable length data and doesn't require a severe restriction on response time

3.2.29**monitor**

class or its instance object of FDC ASE that plays a role of a watcher or subscriber of commands and response between other communication nodes for the Type 27 FAL

3.2.30**monitor slave**

variant of slave AP type that has both slave class and monitor class for FDC ASE of the Type 27 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 that plays a role of a command requester or sender for the Type 27 FAL

3.2.34**responder**

class or its instance object of MSG ASE that plays a role of a command responder or receiver for the Type 27 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 27 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 27 FAL, or the device implementing that AP type

3.2.39

slave

FDC slave

class or its instance object of FDC ASE that plays a role of a responder for the Type 27 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 27 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 61158-6-27, 4.4 and Annex A).

3.2.42

synchronous communication

state or a way of communication for the FDC service of the Type 27 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 27 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 27 fieldbus; cyclic mode, event driven mode

3.2.45

virtual memory space

large data block of APOs for the Type 27 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 vendor specific area. See IEC 61158-6-27, 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 27 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 27 fieldbus)
APC SM	Application Process Context State Machine (for Type 27 fieldbus)
AR	Application Relationship
AR ASE	Application Relationship Application Service Element
AREP	Application Relationship End Point
ARPM	Application Relationship Protocol Machine (for Type 27 fieldbus)
ARPM-FDCM	ARPM for Field Device Control service Master (for Type 27 fieldbus)
ARPM-FDCMN	ARPM for Field Device Control service Monitor (for Type 27 fieldbus)
ARPM-FDCS	ARPM for Field Device Control service Slave (for Type 27 fieldbus)
ARPM-MSG	ARPM for Message service (for Type 27 fieldbus)
ASCII	American Standard code for Information Interchange
ASDU	Application Service Data Unit
ASE	Application Service Element
ASN.1	Abstract Syntax Notation One
Cnf	Confirm primitive
CTC	Communication Transmission Control
DL	Data-link-layer
DL-	(as a prefix) Data Link-
DLL	Data Link Layer
DLM	Data Link-management
DLMS	DL-management service
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 27 fieldbus)
FDC ASE	Field Device Control Application Service Element (for Type 27 fieldbus)
FDCPM	Field Device Control Protocol Machine (for Type 27 fieldbus)
FDCPM-M	Field Device Control Protocol Machine for Master (for Type 27 fieldbus)

FDCPM-MN	Field Device Control Protocol Machine for Monitor (for Type 27 fieldbus)
FDCPM-S	Field Device Control Protocol Machine for Slave (for Type 27 fieldbus)
FIFO	First In First Out
FSPM	FAL service protocol machine
FSM-	Fieldbus System Management (as prefix of a service for Type 27 fieldbus)
FSM ASE	Fieldbus System Management Application Service Element for Type 27 fieldbus
FSMS	Fieldbus System management service
FSMUL	Field System Management Underlying Layer
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 27 fieldbus)
MSG ASE	Message Application Service Element for Type 27 fieldbus
MSGPM	Message Protocol Machine for Type 27 fieldbus
MSGPM-RQ	MSGPM for Requester for Type 27 fieldbus
MSGPM-RS	MSGPM for Responder for Type 27 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 27 fieldbus)
SAP	Service Access Point
SDN	Send Data with no Acknowledge
SDU	Service Data Unit
SM	Sync Master
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 indicates 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

- 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
- 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

4.1 Common concepts

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

4.2 Type specific concepts

4.2.1 General

This document and its companion Type 27 documents described a real-time Ethernet technology that aims to maximize the utilization of the full duplex Ethernet bandwidth.

4.2.2 Node type

There are two node types; the master type and the slave type.

1) C1 master

One node shall exist as the master within the control domain in any case. The master executes the communication initialization before starting the sync communication. Handling of the communication initialization is executed by the application layer. After that, it executes cyclic transmissions and message transmissions with the slave in the control domain. Also, it controls the timing to switch transfer methods in the control domain that it manages.

2) Slave

Multiple nodes exist as the slave within the network. The slave can belong to multiple control domains, and it controls the timing to switch transfer methods and the timing to send from its own node in the control domain that it belongs to. The timing to send and the timing to switch

transfer methods are either notified from the master of the control domain that it belongs to upon communication initialization or set by the application layer. After communication initialization, it executes cyclic transmissions and message transmissions with the master of the control domain that it belongs to.

Other than the two node types described above, another node also exists as the only unit in the same network, and it has the sync control function for the entire network. The node with this function is referred to as the "sync master". The sync master measures the transmission delay time from its own node to all the nodes in the network and sends a SYNC command upon start of transmission cycle.

Also, other than the sync master, the "band master" exists in the same network. The band master handles the delay measurement among the sync master and other nodes and controls the parameters for scheduling of the control domain band and the IP transmission band within the network. One master in the same network needs to have the band master function.

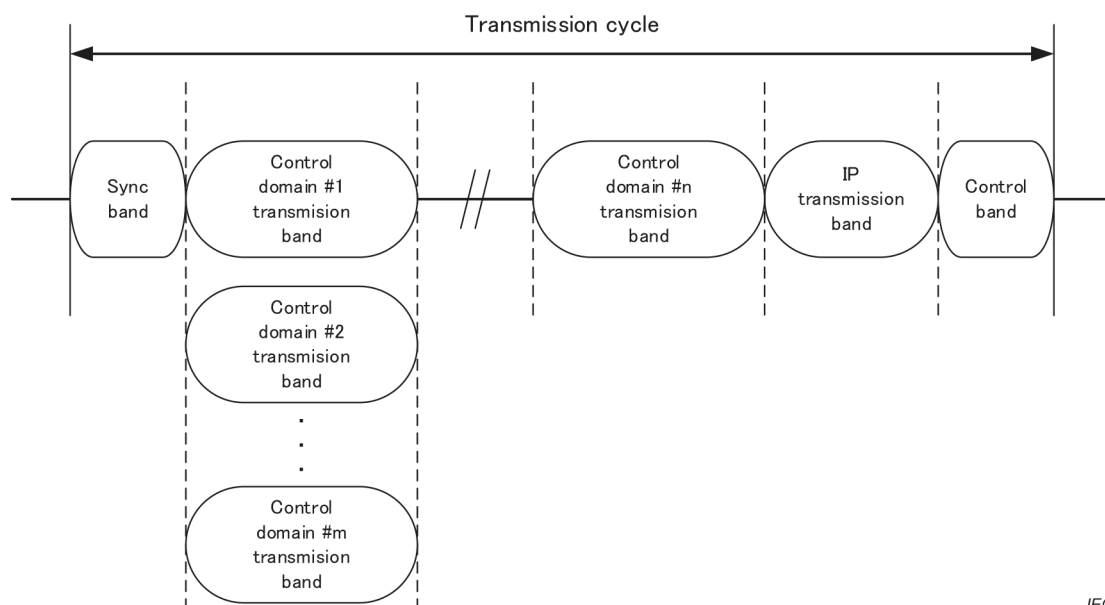
4.2.3 Basic system configuration

The system consists of one master having the sync master function and the band master function and N slaves that belong to the control domain, and the system executes 1:N communications. In this system, the output data or the input data is sent one time within the transmission cycle that the master manages.

4.2.4 Communication sequence overview

4.2.4.1 Transmission cycle

The transmission cycle is divided into bands as shown in Figure 1 and Figure 2. Figure 1 shows a pattern containing multiple control domain transmission bands with concurrent I/O data exchange. Figure 2 shows a pattern containing multiple control domain transmission bands with sequential I/O data exchange.



IEC

Figure 1 – Transmission cycle with concurrent I/O data exchange

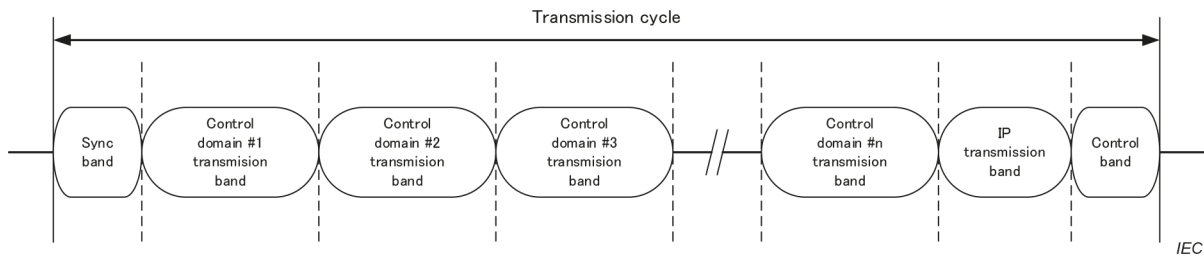


Figure 2 – Transmission cycle with sequential I/O data exchange

4.2.4.2 Sync band

The sync master transmits the SYNC command to this band.

4.2.4.3 Control domain transmission band

This band is used for exchanging of control data between the master and the slaves, and the timing sequence is as shown in Figure 3. This timing sequence is basically common to all control domains. The master collectively sends the output data for multiple slaves and each slave sends the input data of its own node as one command. As for the output data, consecutive transmissions for multiple times can be selected (Figure 3 shows two consecutive transmissions). As for the input data, the master can make a retransmission request.

Also, the master can send / receive message data to the slaves. Figure 3 shows the message transmission from master to slaves. The master becomes the primary node and the slaves become the secondary node.

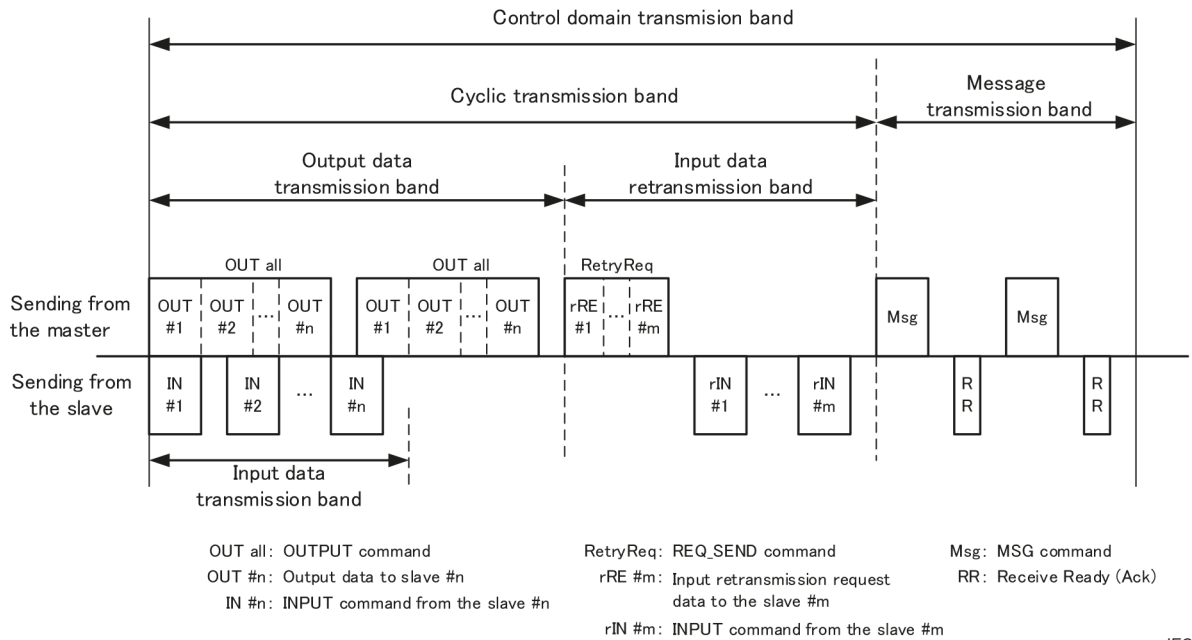


Figure 3 – Control domain transmission band

4.2.4.4 IP band

The IP band executes IP packets transmissions. This is an option band.

4.2.4.5 Control band

The control band is for network reset. The band master sends reset request to the sync master in this band.

4.2.5 Network initialization

Network initialization is executed by the master having the band master function before the start of cyclic communication.

The master having the band master function manages the connection status of all nodes in the network. Accordingly, the master having the band master function needs either to have the information on the devices to be connected in advance before starting up of the system or to collect the information on the devices to be connected by detecting the connecting nodes.

4.2.6 Multi control domain system

The multi control domain system is a system containing multiple control domains within the network. It can not only control the domains by the separate master but also control multiple domains by one master. Also, one slave can be controlled by multiple domains.

4.2.7 Multiple transmission cycles

The master can control multiple transmission cycles (cycles for exchanging the control data) with the slaves within the control domain. While exchanging of control data is executed every transmission cycle in a basic communication, slaves for exchanging the control data in divided cycles can be mixed.

4.2.8 Sync master switching

When the sync master is allocated to a node other than the band master and the allocated node is disconnected from the network due to stopping or cable disconnection, the sync state can be maintained by automatically switching the sync master to another node to send a sync notification. Note that this function can be used only when the band master is not the sync master. The normal sync master before switching is referred to as the primary sync master and the second sync master after switching is referred to as the secondary sync master. Only one node respectively for these sync masters can exist in the network.

4.2.9 TSN

A node with the synchronous manager function can connect to a TSN network. By synchronizing this node with the TSN time according to IEEE Std 802.1AS, it is possible to share the TSN time among all the nodes in M-4 network.

5 Data type ASE

In the communication Type 27 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 61158-6-27 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 61158-6-27.

6 Communication model specifications

6.1 Type specific concepts

The application layer of the Type 27 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 27 FAL, the communication models consist of five types of ASE and three 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 series.

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 27, 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 27 FAL models an ASE structure and their roles for the fieldbus system based on a network that consists of multiple devices among two AP types. These are master and slave (see Table 1).

To establish a communication system, one or more masters and one or more slaves are required within one network.

Furthermore, five kinds of service entities are provided for the FAL user process in the Type 27 FAL. Figure 4 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 three 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. FSM ASE can detect the connection nodes by communication processing, implement node-to-node transmission delay measurements, and execute parameter remote settings. This fieldbus type can provide FAL users with four types of communication services with different characteristics by using these three types of ASEs. Also, among these ASEs, FSM ASE contributes to AP context creation and object instantiation within the other 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 6.4 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. Furthermore, it manages the timing to start the control domain and the timing of communication functions provided by FDC ASE and MSG ASE.

Table 1 – AP type definition

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

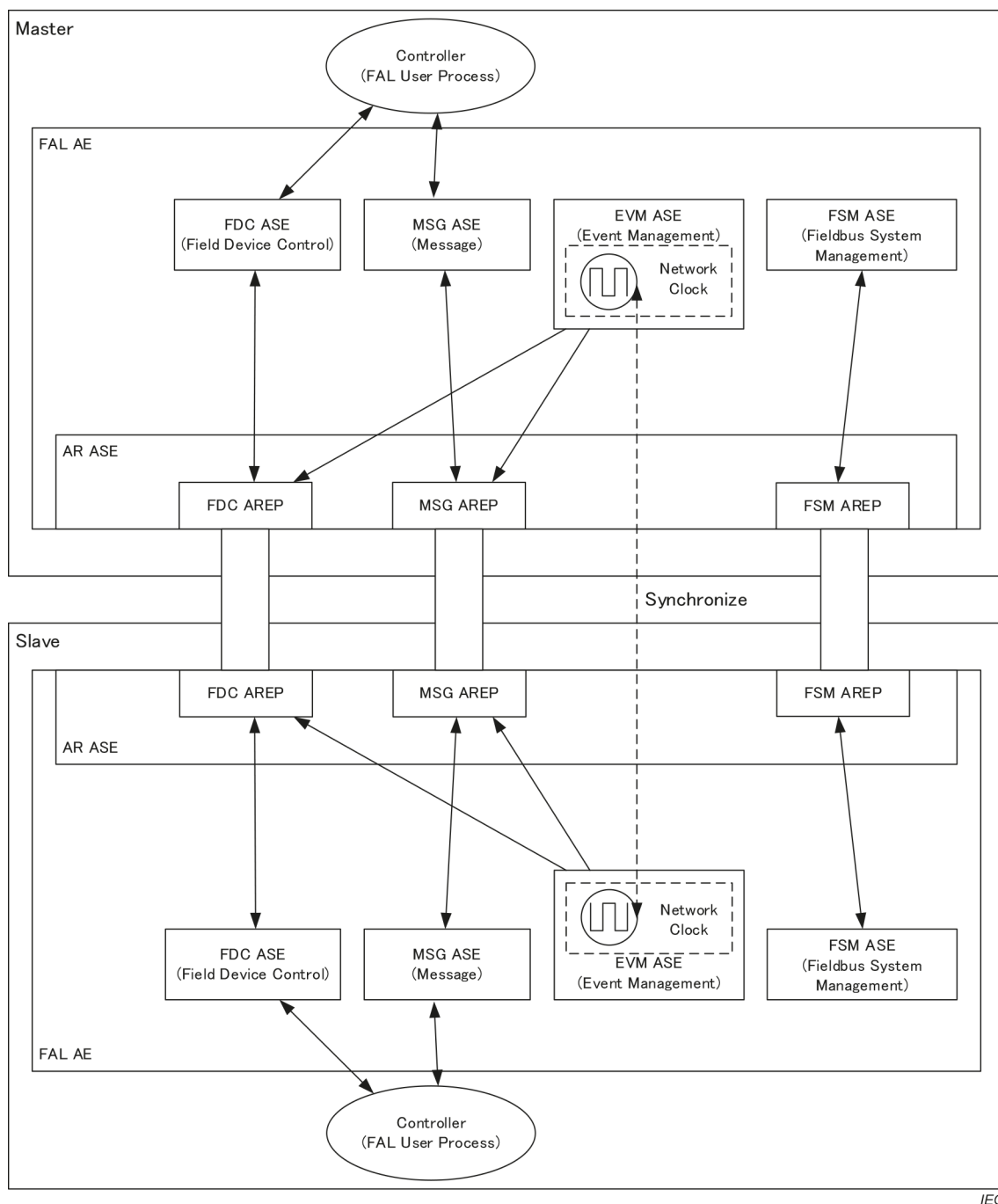


Figure 4 – FAL ASE model of Type 27

6.3 FAL ASEs

6.3.1 FSM ASE

6.3.1.1 Concepts

6.3.1.1.1 General

As described in 6.2, the object classes to be supported are defined for each AP type in the Type 27 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, etc.

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 FAL, disable control, and association management among entities and objects by using communication node address, SAPID, AREP ID, etc.

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.

6.3.1.1.2 FAL common services for system management

In the Type 27 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.

6.3.1.1.3 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-SetContext	FieldbusSystemManager	M			M
FSM-GetContext	FieldbusSystemManager	M			M
FSM-GetTopology	FieldbusSystemManager	U			U
FSM-InformTopology	FieldbusSystemManager	U			U
FSM-ChangeAddress	FieldbusSystemManager	U			U
FSM-Start	FieldbusSystemManager	M			M

6.3.1.2 FieldbusSystemManager class specifications

6.3.1.2.1 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-SetContext	
3	(m)	OpsService	FSM-GetContext	
4	(o)	OpsService	FSM-GetTopology	
5	(o)	OpsService	FSM-InformTopology	
6	(o)	OpsService	FSM-ChangeAddress	
7	(m)	OpsService	FSM-Start	

6.3.1.2.2 FieldbusSystemManager class attribute definition

6.3.1.2.2.1 Numeric Identifier

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

6.3.1.2.2.2 Name

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

6.3.1.2.2.3 User Description

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

6.3.1.2.2.4 Object Revision

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

6.3.1.2.2.5 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.

6.3.1.2.2.6 State

This attribute contains a state number of a state machine APC SM (see IEC 61158-6-27, Clause 7), which is the main function of this object.

6.3.1.2.2.7 APTYPE

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

- 1: master;
- 2: slave.

6.3.1.2.2.8 CONTEXT-DATA

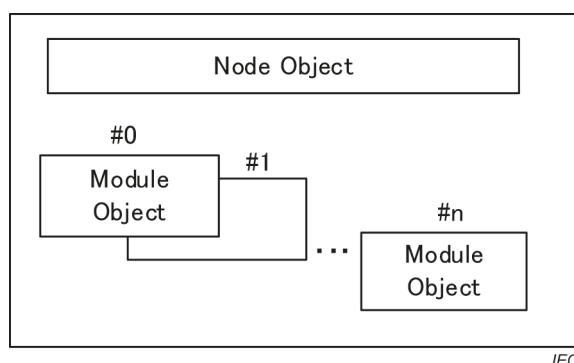
This attribute contains a various system configuration data input that are inputted by a user, configuration information detected in the network directly, system condition at run-time, etc. The detailed specification and data structure depend on the implementation.

The configuration of data to be set for this attribute, Communication Data Object (CDO), is as described below.

CDO consists of the following two types of objects (see Figure 5).

- Node object;
- Module object.

Node object is an object unique (common) to the node such as communication parameter in the node. Module object is an individual object for module (servo, I/O, etc.) to be implemented to the node.



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Figure 5 – CDO (Communication Data Object)

For a single-axis node, one module object is implemented for the slave. For a node consolidating multiple axes, module objects for the number of axes to be implemented are implemented.

CDO is implemented as a resource to set the operation condition such as transmission cycle with the remote node and to refer to the node state. Access is made by designating the address. Some CDOs can handle local objects to be described later. As the common specification of CDO, the value 0 shall mean unsupported or not set.

Overall structure of CDO is as shown in Table 3.

Table 3 – Overall structure of CDO

CDO Address	Description
'0000'H to '41FF'H	Node object
'5000'H to '9FFF'H	Module object (0 to 127)

There are node object categories as shown in Table 4.

Table 4 – Node object categories

CDO Address	Category	Access type
'0000'H to '001F'H	Object information	R (read only)
'0020'H to '002F'H	Object status	R (read only)
'0030'H to '003F'H	Control	R/W (read /write allowed)
'0040'H to '41FF'H	Configuration	R/W (read / write allowed)

There is a module object category as shown in Table 5.

Table 5 – Module object category

CDO Address	Category	Access type
'5000'H to '9FFF'H	Configuration	R/W (read /write allowed)

Details of node objects are as shown from Table 6 to Table 9, and details of module objects are as shown in Table 10.

The following tables are described with LSB first.

Table 6 – List of node objects (object information)

Offset Address	Name	Size	Unit	Range	Access Type	Related variable	Implementation level	
							Master	Slave
'0000'H	Protocol version	Unsigned32		0	R		M	M
'0004'H	Reserve	Unsigned8		0	R		M	M
'0005'H	Type	Unsigned4		1: Master 2: Slave	R		M	M
'0005'H	Sync master capability	Unsigned1		0: Unsupported, 1: Supportable a	R		M	M
'0005'H	Reserve	Unsigned3		0				
'0006'H	Reserve	Unsigned8		0				
'0007'H	Number of implementation ports	Unsigned8		1 to 2	R		M	M
'0008'H	Port 0 attribute	Unsigned2		0: Unimplemented, 1: Implemented, Other: Not used	R		M	M
'0008'H	Port 1 attribute	Unsigned2		The same as Port 0 attribute	R		M	M
...					R			
'0008'H	Port 3 attribute	Unsigned2		The same as Port 0 attribute	R		M	M
'0009'H	Port 4 attribute	Unsigned2		The same as Port 0 attribute	R		M	M
...					R			
'000B'H	Port 15 attribute	Unsigned2		The same as Port 0 attribute	R		M	M
'000C'H	local MAC address	Unsigned48		b	R	V(MAC)	M	M
'0012'H	Chip information	Unsigned16		Implementation dependent	R		O	O
'0014'H	transmission cycle lower limit	Unsigned32	ns	16 250 to 80 000 000	R		M	M
'0018'H	transmission cycle lower limit	Unsigned32	ns	16 250 to 80 000 000	R		M	M
'001C'H	Chip ID	Unsigned32		ASCII code4 characters High-order 3characters: Chip type Low-order 1character: Chip version	R		M	M
M: Mandatory, O: Optional, C: Conditional, Blank: Without implementation								
a When this can be supported, it shall have both the primary and secondary sync master abilities.								
b In accordance with the rules of IEEE Std 802-2014, Clause 9.								

Table 7 – List of node objects (object status)

Offset Address	Name	Size	Unit	Range	Access Type	Related variable	Implementation level	
							Master	Slave
'0020'H	FSMUL status	Unsigned8		FSMUL status number	R	V(Ndlsts)	M	M
'0021'H to '0023'H	Reserve	Unsigned24		0			M	M
'0024'H	Error status	Unsigned32		0: No error, Other than 0: error detected	R		M	M
'0028'H	Port 0 status	Unsigned2		0: Not connected, 1: M-4 supported device connected, 2: M-4 unsupported device connected, 3: Reserve	R	V(P0sts)	M	M
'0028'H	Port 1 status	Unsigned2		The same as Port 0 status	R	V(P1sts)	M	M
...								
'0028'H	Port 3 status	Unsigned2		The same as Port 0 status	R	V(P3sts)	M	M
'0029'H	Port 4 status	Unsigned2		The same as Port 0 status	R	V(P4sts)	M	M
...								
'002B'H	Port 15 status	Unsigned2		The same as Port 0 status	R	V(P15sts)	M	M
'002C'H to '002F'H	Reserve			0				
M: Mandatory, O: Optional, C: Conditional, Blank: Without implementation								

Table 8 – List of node objects (control)

Offset Address	Name	Size	Unit	Range	Access Type	Related variable	Implementation level	
							Master	Slave
'0030'H	Repeat transfer permission	Unsigned1		0: Ignore, 1: Permit	W		M	M
'0030'H	Control data exchange: Start	Unsigned1		0: Ignore, 1: Start	W		M	M
'0030'H	Control data exchange: Stop	Unsigned1		0: Ignore, 1: Stop	W		M	M
'0030'H	Event driven communication permission	Unsigned1		0: Ignore, 1: Permit	W		M	M
'0030'H	Event driven communication : Stop	Unsigned1		0: Ignore, 1: Stop	W		M	M
'0030'H	Reserve	Unsigned2		0				
'0030'H	FSMUL reset	Unsigned1		0: Ignore, 1: FSMUL reset	W		M	M
'0031'H to '003F'H	Reserve			0				
M: Mandatory, O: Optional, C: Conditional, Blank: Without implementation								

As for the FSMUL control write response, the response shall be returned after the contents of control have been completed.

For example, in the case that the repeat transfer permission has been rewritten, the response shall be sent when the transfer method switching process has been completed.

Table 9 – List of node objects (configuration)

Offset Address	Name	Size	Unit	Range	Access Type	Related variable	Implementation level	
							Master	Slave
'0040'H	Local station address	Unsigned16		'0001'H to 'FFEF'H	R/W	V(MA)	M	M
'0042'H	Number of control domains belonging	Unsigned8		1 to 4	R/W	V(Nbdom)	O	M
'0043'H	Number of control domains managing	Unsigned8		1 to 4	R/W	V(Nmdom)	M	
'0044'H	Transmission delay from the sync master to local station	Unsigned32	ns	0 to 40 000 000	R/W	V(T_{dly})	M	M
'0048'H	Transmission delay from the secondary sync master	Unsigned32	ns	0 to 40 000 000	R/W	V(T_{dly2})	O	O
'004C'H to '004F'H	Reserve			0			M	M
'0050'H	Transmission cycle	Unsigned32	ns	15 625 to 64 000 000	R/W	V(T_{cycle})	M	M

Offset Address	Name	Size	Unit	Range	Access Type	Related variable	Implementation level	
							Master	Slave
'0054'H	Sync band width	Unsigned32	ns	0 to 4 000 000	R/W	$V(T_{\text{sync_w}})$	M	M
'0058'H	Reserve	Unsigned32	ns	0	R		M	M
'005C'H	IP transmission band width	Unsigned32	ns	0 to 63 999 999	R/W	$V(T_{\text{ip_w}})$	M	M
'0060'H	Control band width	Unsigned32	ns	0 to 63 999 999	R/W	$V(T_{\text{ctrl_w}})$	O	O
'0064'H	MAC address of the band master	Unsigned48		a	R/W	$V(\text{MACbm})$	M	M
'006A'H	Node address of the band master	Unsigned16		'0001'H to 'FFEF'H	R/W	$V(\text{MAbm})$	M	M
'006C'H	MAC address of the sync master	Unsigned48		a	R/W	$V(\text{MACsm})$	M	M
'0072'H	Node address of the sync master	Unsigned16		'0001'H to 'FFEF'H	R/W	$V(\text{MAsm})$	M	M
'0074'H	Multicast address common to all the control domains	Unsigned48		a	R/W	$V(\text{MACmlt0})$	M	M
'007A'H	Node address of the secondary sync master	Unsigned16		'0001'H to 'FFEF'H	R/W	$V(\text{MAsm2})$	M	M
'007C'H	Transmission stop count	Unsigned8		3 to 10	R/W	$V(\text{Nstop_tx})$	M	M
'007D'H	Reserve			0	R		M	M
'007E'H	Guard band width	Unsigned16	ns	'0 to 10 000	R/W	$V(T_{\text{guard_w}})$	M	M
'0080'H	MAC address for the multicast which belongs to the control domain #1	Unsigned48		a	R/W	$V(\text{MACmlt_s1})$	C	M
'0086'H	Node address of the master which belongs to the control domain #1	Unsigned16		'0001'H to 'FFEF'H	R/W	$V(\text{MAmst_s1})$	C	M
'0088'H	Slave control data transmission time which belongs to the control domain #1 (offset time from the control domain starting time)	Unsigned32	us	0 to 63 999 999	R/W	$V(T_{\text{txio_s1}})$	C	M
'008C'H	Control domain starting time which belongs to the control domain #1	Unsigned32	us	0 to 63 999 999	R/W	$V(T_{\text{dom_st_s1}})$	C	M
'0090'H	Control domain band width (time retained) which belongs to the control domain #1	Unsigned32	us	0 to 63 999 999	R/W	$V(T_{\text{dom_w_s1}})$	C	M
'0094'H to '0097'H	Reserve			0	R		M	M

Offset Address	Name	Size	Unit	Range	Access Type	Related variable	Implementation level	
							Master	Slave
'0098'H	Message length (data part) which belongs to the control domain #1	Unsigned16		0 to 1 490	R/W	V(Lmsg_s1)	O	M
'009A'H	Validity of Upstream input data transmission which belongs to the control domain #1	Unsigned1		0:Upstream setting Invalid 1:Upstream setting Valid	R/W	V(TXup_s1)	C	M
'009A'H	Reserve	Unsigned7		0	R		M	M
'009B'H	Reserve	Unsigned8		0	R		M	M
'009C'H	Sync timing (offset time from the control domain starting time) which belongs to the control domain #1	Unsigned32		0 to 63 999 999	R/W	V(Tslv_sync_s1)	C	M
'00A0'H to '00AF'H	Reserve			0	R		M	M
'00B0'H	Node address in local node (node 0) information which belongs to the control domain #1	Unsigned16		'0001'H to 'FFEF'H	R/W	V(MA_n0_s1)	C	M
'00B2'H	Reserve			0	R		M	M
'00B4'H	Exponent of division ratio in local node (node 0) information which belongs to the control domain #1	Unsigned3		0 to 5	R/W	V(Ntcyc_dev_n0_s1)	C	M
'00B4'H	Reserve	Unsigned5		0	R		M	M
'00B5'H	Transmission cycle including the sync point (Valid when the division ratio >1) in local node (node 0) information which belongs to the control domain #1	Unsigned8		0 to (Division ratio - 1)	R/W	V(Ntcyc_num_n0_s1)	C	M
'00B6'H	Upstream port in local node (node 0) information which belongs to the control domain #1	Unsigned4		0 to 15	R/W	V(Nup_port_n0_s1)	C	M
'00B6'H	Control domain end node in local node (node 0) information which belongs to the control domain #1	Unsigned1		0: Not a domain end, 1: domain End	R/W	V(Fdom_end_n0_s1)	C	M
'00B6'H	Reserve			0	R		M	M

Offset Address	Name	Size	Unit	Range	Access Type	Related variable	Implementation level	
							Master	Slave
'00B7'H	Number of module objects within the node in local node (node 0) information which belongs to the control domain #1	Unsigned8		0 to 127	R/W	V(Ndev_num_n0_s1)	C	M
'00B8'H to '00BF'H	Reserve			0		R	M	M
'00C0'H to '00CF'H	Other node (node1) information which belongs to the control domain #1 (the same as '00B0'H to '00BF'H)				R/W	V(**_n1_s1)	C	C
'00D0'H to '00DF'H	Other node (station2) information which belongs to the control domain #1 (the same as '00B0'H to '00BF'H)				R/W	V(**_n2_s1)	C	C
...								
'08A0'H to '08AF'H	Other node (node127) information which belongs to the control domain #1 (the same as '00B0'H to '00BF'H)				R/W	V(**_n127_s1)	C	C
'08B0'H to '10DF'H	Item about which belongs to the control domain #2 (the same as '0080'H to '08AF'H)				R/W	V(**_n1_s2) to V(**_n127_s2)		C
'10E0'H to '190F'H	Item which belongs to the control domain #3 (the same as '0080'H to '08AF'H)				R/W	V(**_n1_s3) to V(**_n127_s3)		C
'1910'H to '213F'H	Item which belongs to the control domain #4 (the same as '0080'H to '08AF'H)				R/W	V(**_n1_s4) to V(**_n127_s4)		C
'2140'H to '21FF'H	Reserve			0	R		M	M
'2200'H	MAC address for multicast which manages control domain #1	Unsigned48		a	R/W	V(MACmlt_m1)	M	

Offset Address	Name	Size	Unit	Range	Access Type	Related variable	Implementation level	
							Master	Slave
'2206'H	Master node address which manages control domain #1	Unsigned16		'0001'H to 'FFEF'H	R/W	V(MAmst_m1)	M	
'2208'H	Slave control data transmission timing which manages the control domain #1 (offset time from the control domain start time)	Unsigned32		0 to 63 999 999	R/W	V(Ttxio_m1)	M	
'220C'H	Control domain start time which manages control domain #1	Unsigned32		0 to 63 999 999	R/W	V(Tdom_st_m1)	M	
'2210'H	Control domain band width (time retained) which manages control domain #1	Unsigned32		0 to 63 999 999	R/W	V(Tdom_w_m1)	M	
'2214'H to '2217'H	Reserve			0	R		M	M
'2218'H	Message packet length (data part) which manages the control domain #1	Unsigned16		0 to 1 490	R/W	V(Lmsg_m1)	O	
'221A'H	Upstream only input data transmission which manages the control domain #1	Unsigned1		0:Upstream setting Invalid 1:Upstream setting Valid	R/W	V(TXup_m1)	M	
'221A'H	Reserve	Unsigned7		0	R		M	M
'221B'H	Reserve	Unsigned8		0	R		M	M
'221C'H	Slave sync timing (offset time from control domain start time) which manages control domain #1	Unsigned32	ns	0 to 63 999 999	R/W	V(T _{slv_sync_m1})	M	
'2220'H	Sync timing (offset time from control domain start time) which manages control domain #1	Unsigned32	ns	0 to 63 999 999	R/W	V(T _{mst_sync_m1})	M	
'2224'H	Number of nodes which manages control domain #1	Unsigned8		1 to 127	R/W	V(Nnode_m1)	M	
'2225'H	Number of output data transmission times which manages control domain #1	Unsigned8		1 to 4	R/W	V(Nout_m1)	O	

Offset Address	Name	Size	Unit	Range	Access Type	Related variable	Implementation level	
							Master	Slave
'2226'H	Number of maximum retransmission request times which manages control domain #1	Unsigned8		0 to 127	R/W	V(Nretry_m1)	O	
'2227'H	Number of retry nodes which manages the control domain #1	Unsigned8		0 to 127	R/W	V(Nretry_node_m1)	O	
'2228'H	Port 0 downstream setting which manages the control domain #1	Unsigned1		0: Downstream setting Invalid 1:Downstream setting Valid	R/W	V(Ftx_down0_m1)	M	
'2228'H	Port 1 downstream setting which manages the control domain #1	Unsigned1		0: Downstream Invalid 1:Downstream Valid	R/W	V(Ftx_down1_m1)	M	
...								
'2229'H	Port 15 downstream setting which manages control domain #1	Unsigned1		0: Downstream Invalid 1:Downstream Valid	R/W	V(Ftx_down15_m1)	M	
'222A'H	Master control domain end setting which manages the control domain #1	Unsigned1		0: Not a domain end, 1: domain End	R/W	V(Fdom_end_mst_m1)	M	
'222B'H	Reserve			0	R		M	M
'222C'H	Input/output data transmission band width which manages the control domain #1	Unsigned32	ns	0 to 63 999 999	R/W	V(T _{io_w})	M	
'2230'H	Input data resend band width which manages the control domain #1	Unsigned32	ns	0 to 63 999 999	R/W	V(T _{retry_w})	M	
'2234'H to '223F'H	Reserve			0	R		M	M
'2240'H	Node address in node 0 information which manages the control domain #1	Unsigned16		'0001'H to 'FFEF'H	R/W	V(MA_n0_m1)	M	
'2242'H	Reserve			0	R		M	M
'2243'H	Reserve			0	R		M	M
'2244'H	Small division ratio in node 0 information which manages the control domain #1	Unsigned3		0 to 5	R/W	V(Ntcyc_dev_n0_m1)	M	
'2244'H	Reserve			0	R		M	M

Offset Address	Name	Size	Unit	Range	Access Type	Related variable	Implementation level	
							Master	Slave
'2245'H	Transmission cycle including the sync point (valid when the division ratio >1) in node 0 information which manages the control domain #1	Unsigned8		0 to (division ratio - 1)	R/W	V(Ntcyc_num_n0_m1)	M	
'2246'H	Upstream port in node 0 information which manages the control domain #1	Unsigned4		0 to 15	R/W	V(Nup_port_n0_m1)	M	
'2246'H	Control domain end node in node 0 information which manages the control domain #1	Unsigned1		0: Not a domain end, 1: domain End	R/W	V(Fdom_end_n0_m1)	M	
'2246'H	Reserve			0	R		M	M
'2247'H	Number of module objects within the node in node 0 information which manages the control domain #1	Unsigned8		0 to 127	R/W	V(Ndev_num_n0_m1)	M	
'2248'H	Transmission delay from the sync master in node 0 information which manages the control domain #1	Unsigned32	ns	0 to 40 000 000	R/W	V(T _{smdly} _n0_m1)	M	
'224C'H	Transmission delay from the master in node 0 information which manages the control domain #1	Unsigned32	ns	0 to 40 000 000	R/W	V(T _{mstdly} _n0_m1)	M	
'2250'H to '225F'H	Node 1 information which manages the control domain #1 (the same as '2240'H to '224F'H)					V(**_n1_m1)	C	
'2260'H to '226F'H	Node 2 information which manages the control domain #1 (the same as '2240'H to '224F'H)					V(**_n2_m1)	C	
...								
'2A30'H to '2A3F'H	Node 127 information which manages the control domain #1 (the same as '2240'H to '224F'H)				R/W	V(**_n127_m1)	C	