



BSI Standards Publication

Industrial communication networks - Fieldbus specifications

Part 5-26: Application layer service definition - Type 26 elements

National foreword

This British Standard is the UK implementation of EN IEC 61158-5-26:2019. It is identical to IEC 61158-5-26:2019.

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

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

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Date	Text affected
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English Version

Industrial communication networks - Fieldbus specifications -
Part 5-26: Application layer service definition - Type 26 elements
(IEC 61158-5-26:2019)

Réseaux de communication industriels - Spécifications des
bus de terrain - Partie 5-26 : Spécification du protocole de
la couche application - Éléments de type 26
(IEC 61158-5-26:2019)

Industrielle Kommunikationsnetze - Feldbusse - Teil 5-26:
Dienstfestlegungen des Application Layer
(Anwendungsschicht) - Typ 26-Elemente
(IEC 61158-5-26:2019)

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European foreword

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The following dates are fixed:

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-05-23

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Endorsement notice

The text of the International Standard IEC 61158-5-26:2019 was approved by CENELEC as a European Standard without any modification.

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

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

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

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

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61131-3	-	Programmable controllers - Part 3: Programming languages	EN 61131-3	-
IEC 61158-1	2019	Industrial communication networks - Fieldbus specifications - Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series	-	-
IEC 61158-6-26	2019	Industrial communication networks – Fieldbus specifications – Part 6-26: Application layer protocol specification – Type 26 elements	EN 61158-6-26	2019
IEC 61784-2	2019	Industrial communication networks - Profiles - Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC/IEEE 8802-3	-	-
ISO/IEC 646	-	Information technology - ISO 7-bit coded character set for information interchange	-	-
ISO/IEC 7498-1	-	Information technology - Open Systems Interconnection - Basic Reference Model: The Basic Model	-	-
ISO/IEC/IEEE 8802-3	-	Standard for Ethernet	-	-
ISO/IEC 8822	-	Information technology - Open Systems Interconnection - Presentation service definition	-	-
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 10646	-	Information technology - Universal Coded Character Set (UCS)	-	-

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
ISO/IEC 10731	-	Information technology - Open Systems Interconnection - Basic Reference Model - Conventions for the definition of OSI services	-	-
ISO/IEC/IEEE 60559	-	Information technology - Microprocessor Systems - Floating-Point arithmetic	-	-
IETF RFC 768	-	User Datagram Protocol	-	-
IETF RFC 791	-	Internet Protocol	-	-
IETF RFC 792	-	Internet Control Message Protocol	-	-
IETF RFC 793	-	Transmission Control Protocol,	-	-
IETF RFC 796	-	Address mappings	-	-
IETF RFC 826	-	Ethernet Address Resolution Protocol: Or Converting Network Protocol Addresses to 48.bit Ethernet Address for Transmission on Ethernet Hardware	-	-
IETF RFC 894	-	Standard for the Transmission of IP Datagrams over Ethernet Networks	-	-
IETF RFC 919	-	Broadcasting Internet Datagrams	-	-
IETF RFC 922	-	Broadcasting Internet datagrams in the presence of subnets	-	-
IETF RFC 950	-	Internet Standard Subnetting Procedure	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
FIELDBUS SPECIFICATIONS –****Part 5-26: Application layer service definition –
Type 26 elements****FOREWORD**

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International Standard IEC 61158-5-26 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement and control.

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

FDIS	Report on voting
65C/947/FDIS	65C/950/RVD

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

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

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

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

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

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

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 may 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 5-26: Application layer service definition – Type 26 elements

1 Scope

1.1 Overview

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 26 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 International Standard defines in an abstract way the externally visible service provided by the different Types of fieldbus Application Layer in terms of

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

The purpose of this document is to define the services provided to

- a) the FAL user at the boundary between the user and the Application Layer of the Fieldbus Reference Model, and
- b) 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 (see ISO/IEC 7498-1) and the OSI Application Layer Structure (see 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.

This specification may 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

- a) the sizes and octet ordering of various multi-octet service parameters, and
- b) 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 does it 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 fulfill 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 IEC 61784-1 and IEC 61784-2, are maintained simultaneously. Cross-references to these documents within the text therefore refer to the editions as dated in this list of normative references.

IEC 61131-3, *Programmable controllers – Part 3: Programming languages*

IEC 61158-1:2019, *Industrial communication networks – Fieldbus specifications – Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series*

IEC 61158-6-26:2019, *Industrial communication networks – Fieldbus specifications – Part 6-26: Application layer protocol specification – Type 26 elements*

IEC 61784-2:2019, *Industrial communication networks – Profiles – Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC/IEEE 8802-3*

ISO/IEC 646, *Information technology – ISO 7-bit coded character set for information interchange*

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

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

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

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 10646, *Information technology – Universal Coded Character Set (UCS)*

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

ISO/IEC 60559, *Information technology – Microprocessor Systems – Floating-Point arithmetic*

IETF RFC 768, *User Datagram Protocol*, available at <http://www.ietf.org> [viewed 2018-09-20]

IETF RFC 791, *Internet Protocol*, available at <http://www.ietf.org> [viewed 2018-09-20]

IETF RFC 792, *Internet Control Message Protocol*, available at <http://www.ietf.org> [viewed 2018-09-20]

IETF RFC 793, *Transmission Control Protocol*, available at <http://www.ietf.org> [viewed 2018-09-20]

IETF RFC 796, *Address mappings*, available at <http://www.ietf.org> [viewed 2018-09-20]

IETF RFC 826, *An Ethernet Address Resolution Protocol*, available at <http://www.ietf.org> [viewed 2018-09-20]

IETF RFC 894, *A Standard for the Transmission of IP Datagrams over Ethernet Networks*, available at <http://www.ietf.org> [viewed 2018-09-20]

IETF RFC 919, *Broadcasting Internet Datagrams*, available at <http://www.ietf.org> [viewed 2018-09-20]

IETF RFC 922, *Broadcasting Internet Datagrams in the presence of subnets*, available at <http://www.ietf.org> [viewed 2018-09-20]

IETF RFC 950, *Internet Standard Subnetting Procedure*, available at <http://www.ietf.org> [viewed 2018-09-20]

3 Terms, definitions, symbols, abbreviations and conventions

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

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

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

3.1 Terms and definitions from other ISO/IEC standards

3.1.1 Terms and definitions from ISO/IEC 7498-1

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

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

3.1.2 Terms and definitions from ISO/IEC 8822

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

- a) abstract syntax
- b) presentation context

3.1.3 Terms and definitions from ISO/IEC 9545

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

- a) application-association
- b) application-context
- c) application context name
- d) application-entity-invocation
- e) application-entity-type
- f) application-process-invocation
- g) application-process-type
- h) application-service-element
- i) application control service element

3.1.4 Terms and definitions from ISO/IEC 8824-1

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

- a) object identifier
- b) type
- c) value

- d) simple type
- e) structured type
- f) tag
- g) Boolean type
- h) true
- i) false
- j) integer type
- k) bitstring type
- l) octetstring type

3.2 Fieldbus application layer Type 26-specific definitions

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

3.2.1

application

function or data structure for which data is consumed or produced

3.2.2

application objects

multiple object classes that manage and provide a run time exchange of messages across the network and within the network device

3.2.3

application process object

component of an application process that is identifiable and accessible through an FAL application relationship

Note 1 to entry: Application process object definitions are composed of a set of values for the attributes of their class (see the definition for Application Process Object Class Definition). Application process objects can be accessed remotely using the services of the FAL Object Management ASE. FAL Object Management services can be used to load or update object definitions, to read object definitions, and to dynamically create and delete application objects and their corresponding definitions.

3.2.4

application process object class

class of application process objects defined in terms of the set of their network-accessible attributes and services

3.2.5

application relationship

cooperative association between two or more application-entity-invocations for the purpose of exchange of information and coordination of their joint operation

Note 1 to entry: This relationship is activated either by the exchange of application-protocol-data-units or as a result of preconfiguration activities.

3.2.6

application relationship ASE

ASE used for establishing and terminating application relationship

3.2.7

application relationship endpoint

context and behavior of an application relationship as seen and maintained by one of the application processes involved in the application relationship

Note 1 to entry: Each application process involved in the application relationship maintains its own application relationship endpoint.

3.2.8**attribute**

description of an externally visible characteristic or feature of an object

Note 1 to entry: The attributes of an object contain information about variable portions of an object. Typically, they provide status information or govern the operation of an object. Attributes may also affect the behavior of an object. Attributes are divided into class attributes and instance attributes.

3.2.9**behavior**

indication of how an object responds to particular events

3.2.10**channel**

single physical or logical link of an input or output application object of a server to the process

3.2.11**class**

set of objects, all of which represent the same kind of system component

Note 1 to entry: A class is a generalization of an object; a template for defining variables and methods. All objects in a class are identical in form and behavior, but usually contain different data in their attributes.

3.2.12**class attributes**

attribute that is shared by all objects within the same class

3.2.13**client**

<object view> object which uses the services of another (server) object to perform a task

3.2.14**client**

<communication view> initiator of a message to which a server reacts

3.2.15**common-memory**

virtual memory accessible with logically unique address used for the cyclic-data transmission

Note 1 to entry: It is composed of the memory-area-1 and -2 of the memory size 512 words and 8 192 words respectively and is shared with the Type 26 nodes in a Type 26 fieldbus network.

3.2.16**connection**

logical binding between application objects that are within the same or different devices

Note 1 to entry: Connections can be either point-to-point or multipoint.

3.2.17**consumer**

node or sink that is receiving data from a producer

3.2.18**control commands**

action invocations transferred from client to server to clear outputs, freeze inputs and/or synchronize outputs

3.2.19**cyclic**

repetitive in a regular manner

3.2.20

cyclic-data frame

frame used for the Type 26 cyclic-data transmission

3.2.21

cyclic-data transmission

data transmission with which a Type 26 node sends out data on a pre-assigned area for the node on the common-memory, in broadcasting to all other Type 26 nodes every time the node obtains a token

3.2.22

dedicated AR

AR used directly by the FAL User

Note 1 to entry: On dedicated ARs, only the FAL Header and the user data are transferred.

3.2.23

device

physical hardware connected to the link

Note 1 to entry: A device can contain one or more than one node.

3.2.24

device profile

collection of device dependent information and functionality providing consistency between similar devices of the same device type

3.2.25

end node

producing or consuming node

3.2.26

endpoint

one of the communicating entities involved in a connection

3.2.27

error

discrepancy between a computed, observed or measured value or condition and the specified or theoretically correct value or condition

3.2.28

event

instance of a change of conditions

3.2.29

FA-link protocol

communication protocol for Type 26 fieldbus

Note 1 to entry: It defines the token management, the cyclic data transmission and the message data transmission, with which each Type 26 node performs data transmission on an equal basis.

3.2.30

FAL subnet

subnetworks composed of one or more data link segments, identified by a subset of the network address

3.2.31

frame

synonym for DLPDU

3.2.32**invocation**

act of using a service or other resource of an application process

Note 1 to entry: Each invocation represents a separate thread of control that can be described by its context. Once the service completes, or use of the resource is released, the invocation ceases to exist. For service invocations, a service that has been initiated but not yet completed is referred to as an outstanding service invocation.

3.2.33**index**

address of an object within an application process

3.2.34**instance**

actual physical occurrence of an object within a class that identifies one of many objects within the same object class

EXAMPLE California is an instance of the object class state.

Note 1 to entry: The terms object, instance, and object instance are used to refer to a specific instance.

3.2.35**instance attributes**

attribute that is unique to an object instance and not shared by the object class

3.2.36**instantiated**

object that has been created in a device

3.2.37**logical device**

FAL class that abstracts a software component or a firmware component as an autonomous self-contained facility of an automation device

3.2.38**management information**

network-accessible information that supports managing the operation of the fieldbus system, including the application layer

Note 1 to entry: Managing includes functions such as controlling, monitoring, and diagnosing.

3.2.39**message-data frame**

frame used for the Type 26 message-data transmission

3.2.40**message-data transmission**

sporadic data transmission with which a Type 26 node sends out the message data of request, response, information report, notification upon event happened at the node and so forth, to other Type 26 nodes

3.2.41**method**

synonym for an operational service which is provided by the server ASE and invoked by a client

3.2.42**module**

hardware or logical component of a physical device

3.2.43

multipoint connection

connection from one node to many

Note 1 to entry: Multipoint connections allow messages from a single producer to be received by many consumer nodes.

3.2.44

network

set of nodes connected by some type of communication medium, including any intervening repeaters, bridges, routers and lower-layer gateways

3.2.45

network load measurement function

provision for monitoring and measurement of the communication load over a Type 26 fieldbus with a Type 26 node

3.2.46

object

abstract representation of a particular component within a device, usually a collection of related data (in the form of variables) and methods (procedures) for operating on that data that have clearly defined interface and behavior

3.2.47

participation-request-frame

frame used for a Type 26 node notifying of its participation-request in a Type 26 fieldbus network

3.2.48

peer

role of an AR endpoint in which it is capable of acting as both client and server

3.2.49

physical device

automation or other network device

3.2.50

point-to-point connection

connection that exists between exactly two application objects

3.2.51

property

general term for descriptive information about an object

3.2.52

protocol type

identification of communication protocol

3.2.53

publisher

role of an AR endpoint that transmits APDUs onto the fieldbus for consumption by one or more subscribers

Note 1 to entry: A publisher may not be aware of the identity or the number of subscribers and it may publish its APDUs using a dedicated AR.

3.2.54**pull publisher**

type of publisher that publishes an object in response to a request received from its pull publishing manager

3.2.55**pull publishing manager**

type of publishing manager that requests that a specified object be published in a corresponding response APDU

3.2.56**push publisher**

type of publisher that publishes an object in an unconfirmed service request APDU

3.2.57**push publishing manager**

type of publishing manager that requests that a specified object be published using an unconfirmed service

3.2.58**push subscriber**

type of subscriber that recognizes received unconfirmed service request APDUs as published object data

3.2.59**resource**

processing or information capability of a subsystem

3.2.60**sequence number**

consecutive number used to determine whether a receiving message-data from other nodes has been previously received and is redundant

Note 1 to entry: The sequence number of a node is set to 0 (zero) at the time of the network-startup, and it is incremented by 1 (one) every time a message-data transmission is completed. The sequence number of the node is transmitted to other nodes by the message-data transmission.

3.2.61**server**

<communication view> role of an AREP in which it returns a confirmed service response APDU to the client that initiated the request

3.2.62**server**

<object view> object which provides services to another (client) object

3.2.63**service**

operation or function than an object and/or object class performs upon request from another object and/or object class

3.2.64**subscriber**

role of an AREP in which it receives APDUs produced by a publisher

3.2.65**token**

right to send out data on the transmission medium, which is passed successively from node to node for Type 26 fieldbus network

3.2.66**token-frame**

frame used for hand-over the token between Type 26 nodes

3.2.67**transaction code**

code used to discriminate and identify each data transmission frame, and which represents the transaction of a receiving frame

3.2.68**trigger-frame**

frame used in the network-startup state for a Type 26 node notifying of its entrance into a new participation-request over a Type 26 fieldbus network

3.2.69**valid-linking state**

state in which a token is consecutively circulated among nodes over Type 26 fieldbus network

3.2.70**version of sequence number**

version number of the sequence number in a receiving message-data from other nodes, used to determine whether the receiving message-data is valid and is not overdue

Note 1 to entry: The value is set at the time when a Type 26 node completes to participate in a Type 26 fieldbus network, and is maintained until the node drops out of the Type 26 fieldbus network.

3.2.71**virtual-address-space**

virtual memory space with pseudo logical address, used for the message-transmission

3.3 Abbreviations and symbols

AE	Application entity
AL	Application layer
ALME	Application layer management entity
ALP	Application layer protocol
ALS	Application layer service
AP	Application process
APO	Application process object
APDU	Application protocol data unit
AR	Application relationship
AREP	Application relationship endpoint
ASCII	American Standard Code for Information Interchange
ASE	Application service element
BCT	Broadcast transmission
C_AD1	Data-head-address on common-memory-area-1
C_AD2	Data-head-address on common-memory-area-2
CIM	Computer integrated manufacturing
CM	Common-memory
Cnf	Confirmation
C_SZ1	Data-size on common-memory-area-1
C_SZ2	Data-size on common-memory-area-2
DA	Destination-address
DL-	(as a prefix) data-link-

DLC	Data-link connection
DLCEP	Data-link connection endpoint
DLL	Data-link layer
DLS	Data-link service
DLSAP	Data-link service access point
DLSDU	DL-service-data-unit
DNA	Destination-node-number
DNS	Domain name service
FAL	Fieldbus application layer
HMI	Human-machine interface
H_TYPE	Header-type
ID	Identifier
IEC	International Electrotechnical Commission
Ind	Indication
IP	Internet protocol
ISO	International Organization for Standardization
LME	Layer management entity
LSB	Least Significant Bit
M_ADD	Message-offset-address in the virtual-address-space
MAC	Media Access Control
MAJ_VER	FA-link protocol version: major-version
M_CTL	Message-control
MFT	Allowable-minimum-frame-interval-time
MIN_VER	FA-link protocol version: minor-version
MSB	Most Significant Bit
MSN	Manufacturer's model name of a Type 26 node
M_SZ	Message-data-size in the virtual-address-space
M_RLT	Message result
NDN	Node name of Type 26 node
OSI	Open Systems Interconnect
PDU	Protocol data unit
PhL	Ph-layer
PTP	Point-to-Point
P_TYPE	Protocol-type
RCT	Allowable-refresh-cycle-time
Req	Request
RMT	Refresh-cycle-measurement-time
Rsp	Response
RT	Real Time
SA	Source-address
SAP	Service access point
SDU	Service data unit
SEQ	Sequence-number
SNA	Source-node-number
TCD	Transaction code
TCP	Transmission Control Protocol

TW	Token-watchdog
UDP	User Datagram protocol
ULS	Upper layer status
VDN	Vendor code of the node
V_SEQ	Version of sequence number

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. The attributes are accessible from instances of the class using the ASE services specified in 6.5 of this document. The service specification defines the services that are provided by the ASE.

3.4.2 General conventions

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

3.4.3 Conventions for class definitions

Class definitions are described using templates. Each template consists of a list of attributes and services 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. Class IDs are unique.

1 and 255 are reserved by this document to identify standardized classes. They have been assigned to maintain compatibility with existing national standards. CLASS IDs between 256 and 2 048 are allocated for identifying user defined classes.

- d) 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.

- e) The "ATTRIBUTES" label indicate that the following entries are attributes defined for the class.

- 1) 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.
- 2) 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.
- 3) 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
 - i) fields of a structured attribute (4.1, 4.2, 4.3),
 - ii) 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),
 - iii) the selection fields of a choice type attribute (6.1 and 6.2).

- f) The "SERVICES" label indicates that the following entries are services defined for the class.

- 1) 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.
- 2) The label "OpsService" designates an operational service (1).
- 3) The label "MgtService" designates a management service (2).
- 4) 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.

3.4.4 Conventions for service definitions

3.4.4.1 General

The service model, service primitives, and time-sequence diagrams used are entirely abstract descriptions. Therefore, they do not represent a specification for implementation.

3.4.4.2 Service parameters

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

This document uses a tabular format to describe the component parameters of the service primitives. The parameters that apply to each group of service primitives are set out in tables throughout the remainder of this document. Each table consists of up to five columns, containing the name of the service parameter, and a column each for those primitives and parameter-transfer directions used by the service:

- a) parameter name,
- b) request primitive (transmitted from the sender),
- c) indication primitive (transmitted to the receiver),
- d) response primitive (transmitted from the receiver), and
- e) confirm primitive (transmitted to the sender).

One parameter (or part 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 and parameter direction specified in the column:

M	parameter is mandatory for the primitive
U	parameter is a User option, and may or may not be provided depending on the dynamic usage of the service-user. When not provided, a default value for the parameter is assumed.
C	parameter is conditional upon other parameters or upon the environment of the service-user.
(blank)	parameter is never present.
S	parameter is a selected item.

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.

3.4.4.3 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 which support time-constrained communications services within the FAL.

4 Concepts

The FAL is defined as a set of object-oriented ASEs. Each ASE is specified in a separate subclause. Each ASE specification is composed of three parts: the class definitions, the services and the protocol specification. The first two are contained in this document. The protocol specification for each of the ASEs is defined in IEC 61158-6-26.

The fundamental concepts and templates used to describe the application layer service in this document follow Clause 9 of IEC 61158-1.

The FAL defined in this document identifies a peer based controller communications network supporting a Common-memory model in 6.4 as well as client/server models.

5 Data type ASE

5.1 Overview

Fieldbus data types specify the machine independent syntax for application data conveyed by FAL services. The FAL supports the definition and transfer of both basic and constructed data types. Basic types are atomic types. Constructed types are types composed of basic types and other constructed types.

IEC 61158-1, 10.1 provides an overview of the data type ASE and the relationship between data types, and is incorporated herein by reference.

Most basic types are defined from a set of ISO/IEC 8824 types (simple types):

- Basic types have a constant length;
- Two variations are defined, one for defining data types whose length is an integral number of octets, and one for defining data types whose length is bits;
- Some ISO/IEC 8824 types have been extended for fieldbus specific use (specific types). They are defined as simple class subtypes.

Constructed types are of strings, arrays and structures:

- A string shall be composed of an ordered set, variable in number, of homogeneously typed fixed-length elements;
- An array shall be composed of an ordered set of homogeneously typed elements. There are no restrictions on the data type of array elements placed, but each element shall be of the same type;
- A structure shall be made of an ordered set of heterogeneously typed elements called fields. Like arrays, this document does not restrict the data type of fields. However, the fields within a structure do not have to be of the same type.

Data types are defined as instances of the data type class. Defining new types shall be accomplished by providing a new numeric id and supplying values for the attributes defined for the data type class.

User data is transferred between applications by the FAL protocol. All encoding and decoding is performed by the FAL user. The rules for encoding user data in FAL protocol data units are data type dependent. These rules are defined in IEC 61158-6-26.

5.2 Formal definition of data type objects

5.2.1 Data type class definitions

The data type class specifies the root of the data type class tree. Its parent class "top" indicates the top of the FAL class tree. The general form of the template to describe the class definitions is shown below:

FAL ASE:		DATA TYPE ASE
CLASS:		DATA TYPE
CLASS ID:		5 (FIXED LENGTH & STRING), 6 (STRUCTURE), 12 (ARRAY)
PARENT CLASS:		TOP
ATTRIBUTES:		
1	(o) Key Attribute:	Data Type Numeric Identifier
2	(o) Key Attribute:	Data Type Name
3	(m) Attribute:	Format (FIXED LENGTH, STRING, STRUCTURE, ARRAY)
4	(c) Constraint:	Format = FIXED LENGTH STRING
4.1	(m) Attribute:	Octet Length
5	(c) Constraint:	Format = STRUCTURE
5.1	(m) Attribute:	Number of Fields
5.2	(m) Attribute:	List of Fields

5.2.1	(o)	Attribute:	Field Name
5.2.2	(m)	Attribute:	Field Data Type
6	(c)	Constraint:	Format = ARRAY
6.1	(m)	Attribute:	Number of Array Elements
6.2	(m)	Attribute:	Array Element Data Type

5.2.2 Attributes

Data type numeric identifier

This optional attribute identifies the numeric identifier of the related data type.

Data type name

This optional attribute identifies the name of the related data type.

Format

This mandatory attribute identifies the data type as a fixed-length, string, array, or data structure.

Octet length

This conditional attribute defines the representation of the dimensions of the associated type object. It is present when the value of the format attribute is "FIXED LENGTH" or "STRING". For FIXED LENGTH data types, it represents the length in octets. For STRING data types, it represents the length in octets for a single element of a string.

Number of fields

This conditional attribute defines the number of fields in a structure. It shall be present when the value of the format attribute is "STRUCTURE".

List of fields

This conditional attribute is an ordered list of fields contained in the structure. Each field is specified by its number and its type. Fields shall be numbered sequentially from 0 (zero) in the order in which they occur. Partial access to fields within a structure is supported by identifying the field by number. This attribute shall be present when the value of the format attribute is "STRUCTURE".

Field name

This conditional, optional attribute specifies the name of the field. It may be present when the value of the format attribute is "STRUCTURE".

Field data type

This conditional attribute specifies the data type of the field. It shall be present when the value of the format attribute is "STRUCTURE". This attribute may itself specify a constructed data type either by referencing a constructed data type definition by its numeric id, or by embedding a constructed data type definition here. When embedding a description, the embedded-data-type description shown below shall be used.

Number of array elements

This conditional attribute defines the number of elements for the array type. Array elements shall be indexed starting at "0" through "n-1" where the size of the array is "n" elements. This attribute shall be present when the value of the format attribute is "ARRAY".

Array element data type

This conditional attribute specifies the data type for the elements of an array. All elements of the array shall have the same data type. It shall be present when the value of the format attribute is "ARRAY". This attribute may itself specify a constructed data type either by referencing a constructed data type definition by its numeric id, or by embedding a constructed data type definition here. When embedding a description, the embedded-data-type description shown below shall be used.

Embedded data type description

This attribute is used to recursively define embedded data types within a structure or array. The template below defines its contents. The attributes shown in the template are defined above in the data type class, except for the embedded-data-type attribute, which is a recursive reference to this attribute. It is used to define nested elements.

ATTRIBUTES:

1	(m)	Attribute:	Format (FIXED LENGTH, STRING, STRUCTURE, ARRAY)
2	(c)	Constraint:	Format = FIXED LENGTH STRING
2.1	(m)	Attribute:	Data Type Numeric ID value
2.2	(m)	Attribute:	Octet Length
3	(c)	Constraint:	Format = STRUCTURE
3.1	(m)	Attribute:	Number of Fields
3.2	(m)	Attribute:	List of Fields
3.2.1	(m)	Attribute:	Embedded Data Type Description
4	(c)	Constraint:	Format = ARRAY
4.1	(m)	Attribute:	Number of Array Elements
4.2	(m)	Attribute:	Embedded Data Type Description

5.3 FAL defined data types**5.3.1 Fixed length types****5.3.1.1 Boolean types****5.3.1.1.1 Boolean**

FAL ASE:	DATA TYPE ASE
CLASS:	DATA TYPE
CLASS ID:	5
PARENT CLASS:	TOP
ATTRIBUTES:	
1	Data Type Numeric Identifier = 1
2	Data Type Name = Boolean
3	Format = FIXED LENGTH
4.1	Octet Length = 1

This data type expresses a Boolean data type with the values TRUE (non zero) and FALSE (zero).

5.3.1.1.2 BOOL

This IEC 61131-3 type is the same as Boolean.

5.3.1.2 BitString types**5.3.1.2.1 BitString8**

FAL ASE:	DATA TYPE ASE
CLASS:	DATA TYPE
CLASS ID:	5
PARENT CLASS:	TOP
ATTRIBUTES:	
1	Data Type Numeric Identifier = 22
2	Data Type Name = BitString8
3	Format = FIXED LENGTH
5.1	Octet Length = 1

This type contains 1 element of type BitString.

5.3.1.2.2 BitString16

FAL ASE:	DATA TYPE ASE
CLASS:	DATA TYPE
CLASS ID:	5
PARENT CLASS:	TOP
ATTRIBUTES:	
1	Data Type Numeric Identifier = 23
2	Data Type Name = BitString16
3	Format = FIXED LENGTH
5.1	Octet Length = 2

5.3.1.2.3 WORD

This IEC 61131-3 type is the same as BitString16.

5.3.1.2.4 BitString32

FAL ASE:	DATA TYPE ASE
CLASS:	DATA TYPE
CLASS ID:	5
PARENT CLASS:	TOP
ATTRIBUTES:	
1 Data Type Numeric Identifier	= 24
2 Data Type Name	= BitString32
3 Format	= FIXED LENGTH
5.1 Octet Length	= 4

5.3.1.2.5 DWORD

This IEC 61131-3 type is the same as BitString32.

5.3.1.3 Numeric types

5.3.1.3.1 Floating Point types

5.3.1.3.1.1 Float32

FAL ASE:	DATA TYPE ASE
CLASS:	DATA TYPE
CLASS ID:	5
PARENT CLASS:	TOP
ATTRIBUTES:	
1 Data Type Numeric Identifier	= 8
2 Data Type Name	= Float32
3 Format	= FIXED LENGTH
4.1 Octet Length	= 4

This type has a length of four octets. The format for float32 is that defined by ISO/IEC 60559 as single precision.

5.3.1.3.1.2 REAL

This IEC 61131-3 type is the same as Float32.

5.3.1.3.1.3 Float64

FAL ASE:	DATA TYPE ASE
CLASS:	DATA TYPE
CLASS ID:	5
PARENT CLASS:	TOP
ATTRIBUTES:	
1 Data Type Numeric Identifier	= 15
2 Data Type Name	= Float64
3 Format	= FIXED LENGTH
4.1 Octet Length	= 8

This type has a length of eight octets. The format for float64 is that defined by ISO/IEC 60559 as double precision.

5.3.1.3.2 Integer types

5.3.1.3.2.1 Integer8

FAL ASE:	DATA TYPE ASE
CLASS:	DATA TYPE
CLASS ID:	5
PARENT CLASS:	TOP
ATTRIBUTES:	
1	Data Type Numeric Identifier = 2
2	Data Type Name = Integer8
3	Format = FIXED LENGTH
4.1	Octet Length = 1

This integer type is a two's complement binary number with a length of one octet.

5.3.1.3.2.2 SINT

This IEC 61131-3 type is the same as Integer8.

5.3.1.3.2.3 char

This data type is the same as Integer8.

5.3.1.3.2.4 Integer16

FAL ASE:	DATA TYPE ASE
CLASS:	DATA TYPE
CLASS ID:	5
PARENT CLASS:	TOP
ATTRIBUTES:	
1	Data Type Numeric Identifier = 3
2	Data Type Name = Integer16
3	Format = FIXED LENGTH
4.1	Octet Length = 2

This integer type is a two's complement binary number with a length of two octets.

5.3.1.3.2.5 INT

This IEC 61131-3 type is the same as Integer16.

5.3.1.3.2.6 Integer32

FAL ASE:	DATA TYPE ASE
CLASS:	DATA TYPE
CLASS ID:	5
PARENT CLASS:	TOP
ATTRIBUTES:	
1	Data Type Numeric Identifier = 4
2	Data Type Name = Integer32
3	Format = FIXED LENGTH
4.1	Octet Length = 4

This integer type is a two's complement binary number with a length of four octets.

5.3.1.3.2.7 DINT

This IEC 61131-3 type is the same as Integer32.

5.3.1.3.2.8 Integer64

FAL ASE:	DATA TYPE ASE
CLASS:	DATA TYPE
CLASS ID:	5
PARENT CLASS:	TOP
ATTRIBUTES:	
1 Data Type Numeric Identifier	= 55
2 Data Type Name	= Integer64
3 Format	= FIXED LENGTH
4.1 Octet Length	= 8

This integer type is a two's complement binary number with a length of eight octets.

5.3.1.3.2.9 LINT

This IEC 61131-3 type is the same as Integer64.

5.3.1.3.3 Unsigned types**5.3.1.3.3.1 Unsigned8**

FAL ASE:	DATA TYPE ASE
CLASS:	DATA TYPE
CLASS ID:	5
PARENT CLASS:	TOP
ATTRIBUTES:	
1 Data Type Numeric Identifier	= 5
2 Data Type Name	= Unsigned8
3 Format	= FIXED LENGTH
4.1 Octet Length	= 1

This type is a binary number. The most significant bit of the most significant octet is always used as the most significant bit of the binary number; no sign bit is included. This type has a length of one octet.

5.3.1.3.3.2 USINT

This IEC 61131-3 type is the same as Unsigned8.

5.3.1.3.3.3 Unsigned16

FAL ASE:	DATA TYPE ASE
CLASS:	DATA TYPE
CLASS ID:	5
PARENT CLASS:	TOP
ATTRIBUTES:	
1 Data Type Numeric Identifier	= 6
2 Data Type Name	= Unsigned16
3 Format	= FIXED LENGTH
4.1 Octet Length	= 2

This type is a binary number. The most significant bit of the most significant octet is always used as the most significant bit of the binary number; no sign bit is included. This unsigned type has a length of two octets.

5.3.1.3.3.4 UINT

This IEC 61131-3 type is the same as Unsigned16.