

INTERNATIONAL STANDARD

**Industrial communication networks – Fieldbus specifications –
Part 5-19: Application layer service definition – Type 19 elements**





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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
FIELDBUS SPECIFICATIONS –****Part 5-19: Application layer service definition –
Type 19 elements**

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

International Standard IEC 61158-5-19 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This fourth edition cancels and replaces the third edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- improving the hotplug and redundancy features;
- improving the phase switching and the error handling;
- editorial improvements.

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 ISO/IEC Directives, Part 2.

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

The committee has decided that the contents of this 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- withdrawn,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 5-19: Application layer service definition – Type 19 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 19 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 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 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.

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 the 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 61158-4-19:2019, *Industrial communication networks – Fieldbus specifications – Part 4-19: Data-link layer protocol specification – Type 19 elements*

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

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

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 ISO/IEC 7498-1 terms

For the purposes of this document, the following terms as defined 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

3.2 ISO/IEC 8822 terms

For the purposes of this document, the following terms as defined in ISO/IEC 8822 apply:

- a) abstract syntax
- b) presentation context

3.3 ISO/IEC 9545 terms

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

- a) application-association
- b) application-context
- c) application 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

3.4 ISO/IEC 8824-1 terms

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

- a) object identifier
- b) type

3.5 Fieldbus application-layer specific definitions

3.5.1

coded character set

code

set of unambiguous rules that establish a character set and one-to-one relationship between the characters of the set and their representation by one or more bit combinations

3.5.2

cross communication

direct data transfer between slave devices (without active involvement of master)

3.5.3

cycle time

duration of a communication cycle

3.5.4

cyclic data

part of a telegram, which does not change its meaning during cyclic operation of the network

3.5.5

device

slave in the communication network

Note 1 to entry: Examples are a power drive system as defined in the IEC 61800-7 (all parts), I/O stations as defined in IEC 61131 (all parts), etc.

3.5.6

device status

four adjacent octets inside the acknowledge telegram containing status information for each device

3.5.7

element

part of IDNs

Note 1 to entry: Each IDN has 7 elements, whereas each one has a specific meaning (e.g., number, name, data).

3.5.8

hot plug

possibility to open the communication network and insert or remove slaves while the network is still in real-time operation

3.5.9**identification number**

designation of operating data under which a data block is preserved with its attribute, name, unit, minimum and maximum input values, and the data

3.5.10**loopback**

mode by which a device passes on a received telegram to the same port and to the other port, either changed or unchanged

3.5.11**master**

node which assigns the other nodes (i.e., slaves) the right to transmit

3.5.12**physical layer**

first layer of the ISO-OSI reference model

3.5.13**protocol**

convention about the data formats, time sequences, and error correction in the data exchange of communication systems

3.5.14**service channel****SVC**

non real-time transmission of information upon master request during RT channel

3.5.15**slave**

node which is assigned the right to transmit by the master

3.5.16**station**

node

3.5.17**topology**

physical network architecture with respect to the connection between the stations of the communication system

3.6 Abbreviations and symbols

AHS	Service transport handshake of the device (acknowledge HS)
AP	Application Process
APO	Application Object
AR	Application Relationship
AREP	Application Relationship End Point
ASE	Application Service Element
CC-data	Cross Communication
Cnf	Confirmation
DA	Destination address
DAT	Duration of acknowledge telegram
FAL	Fieldbus Application Layer
ID	Identification Number
IDN	Identification Number
Ind	Indication
MS	Master Slave
NRC	Non Real Time Channel
NA	Not applicable
Req	Request
Rsp	Response
RTC	Real Time Channel
RTE	Real Time Ethernet

3.7 Conventions

3.7.1 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 Object Management ASE services specified in Clause 5 of this document. The service specification defines the services that are provided by the ASE.

3.7.2 General conventions

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

3.7.3 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

- (1) The "FAL ASE:" entry is the name of the FAL ASE that provides the services for the class being specified.
- (2) 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.
- (3) 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 between 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 2048 are allocated for identifying user defined classes.
- (4) 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.

- (5) The "ATTRIBUTES" label indicate that the following entries are attributes defined for the class.
 - a) 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.
 - b) 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.
 - c) 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 (Clause 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).
- (6) The "SERVICES" label indicates that the following entries are services defined for the class.
 - a) 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.

- b) The label "OpsService" designates an operational service (1).
- c) The label "MgtService" designates an management service (2).
- d) 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.

3.7.4 Conventions for service definitions

3.7.4.1 General

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

3.7.4.2 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 uses 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

- 1) Parameter name,
- 2) request primitive,
- 3) indication primitive,
- 4) response primitive, and
- 5) 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 parameter is mandatory for the primitive
- U parameter is a User option, and may or may not be provided depending on 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) 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.
- b) 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.

3.7.4.3 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 fieldbus application layer.

4 Concepts

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

5 Data type ASE

Data types as specified in IEC 61158-1, Clause 9 is applied with the following restrictions:

Only nesting level of 1 is supported.

Only the following basic data types are supported:

BitString8
 BitString16
 BitString32
 BitString64
 Unsigned16
 Unsigned32
 Unsigned64
 Integer16
 Integer32
 Integer64
 VisibleString1
 Float32
 Float64

5.1 Bitstring types

5.1.1 BitString8

CLASS:	Data type
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.