IEC 61158-5-18

Edition 2.0 2010-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Industrial communication networks – Fieldbus specifications – Part 5-18: Application layer service definition – Type 18 elements

Réseaux de communication industriels – Spécifications des bus de terrain – Partie 5-18: Définition des services des couches d'application – Eléments de type 18

IEC 61158-5-18:2010-08(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 25.040.40; 35.100.70; 35.110

ISBN 978-2-8322-9144-3

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International Standard IEC 61158-5-18 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This second edition cancels and replaces the first edition published in 2007. This edition constitutes a technical revision.

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

- Editorial corrections
- Addition of cyclic data segmenting

The text of this standard is based on the following documents:

FDIS	Report on voting
65C/606/FDIS	65C/620/RVD

Full information on the voting for the approval of this 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- withdrawn;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.

NOTE 2 The revision of this standard will be synchronized with the other parts of the IEC 61158 series.

INTRODUCTION

This part of IEC 61158 is one of a series produced to facilitate the interconnection of automation system components. It is related to other standards in the set as defined by the “three-layer” fieldbus reference model described in IEC/TR 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 standard 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 standard is a conceptual architectural service, independent of administrative and implementation divisions.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 5-18: Application layer service definition – Type 18 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 18 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 part of IEC 61158 defines in an abstract way the externally visible service provided by the Type 18 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 part of IEC 61158 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 part of IEC 61158 specifies the structure and services of the Type 18 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 standard to provide access to the FAL to control certain aspects of its operation.

1.2 Specifications

The principal objective of this part of IEC 61158 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 part of IEC 61158 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 fulfill the Type 18 application layer services as defined in this part of IEC 61158.

2 Normative references

The following referenced documents are indispensable for the application 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.

IEC 60559, *Binary floating-point arithmetic for microprocessor systems*

IEC/TR 61158-1:2010[1], *Industrial communication networks – Fieldbus specifications – Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series*

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*

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1 To be published

3 Terms, definitions, abbreviations, and conventions

3.1 Referenced terms and definitions

3.1.1 ISO/IEC 7498-1 terms

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

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

3.1.2 ISO/IEC 8822 terms

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

a) abstract syntax
b) presentation context

3.1.3 ISO/IEC 9545 terms

For the purposes of this document, the following terms 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

3.1.4 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

3.2 Additional terms and definitions for distributed automation

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

3.2.1
Register X
register containing bit-oriented cyclic data of type *input data* that is transmitted from a slave to a master

3.2.2
Register Y
register containing bit-oriented cyclic data of type *output data* that is transmitted from a master to a slave

3.2.3
Register Wr
register containing word-oriented cyclic data of type *input data* that is transmitted from a slave to a master

3.2.4
Register Ww
register containing word-oriented cyclic data of type *output data* that is transmitted from a master to a slave

3.3 Abbreviations and symbols

RX Register X

RY Register Y

RWr Register Wr

RWw Register Ww

3.4 Conventions

There are no conventions defined specific to Type 18 FAL.

4 Concepts

4.1 Common concepts

IEC/TR 61158-1:2010, Clause 9 describes the concepts of the application layer service descriptions and the templates used in this document, except as specifically overridden in 4.2.

4.2 Type specific concepts

4.2.1 Overview

Described in this communication model specification are the Application Service Elements (ASE) and the Application Process (AP) object class models. The syntax and related encoding of attributes is described by the Type 18 Application layer protocol specification.

The Type 18 AL identifies two types of FAL user, master and slave. For each FAL user type there are two classes of Data Link Entity (DLE), Class 1 and Class 2, corresponding to the Polled and Packed class of the DLE, respectively. See appropriate definitions and specifications in the Type 18 Data link for more information about the Polled and Packed class of DLE. Therefore, there are 4 types of Application Relationship (AR) as shown in Table 1.

Table 1 – AR types

AR class	Symbol	FAL user type	DLE class
Master Class 1	M1	Master	Polled
Master Class 2	M2	Master	Packed
Slave Class 1	S1	Slave	Polled
Slave Class 2	S2	Slave	Packed

An Application Process (AP) object model consists of

- one Device Manager object,
- one Connection Manager object, and
- one or more Process Data objects.

The specific classes of objects included depend upon the type of device and are identified by prefixes that match the symbol of the related AR class.

4.2.2 Stations and slots

Each device and its corresponding FAL is identified by a number. This identifying number is named the Station number. The station number is the address used to identify the device and the AR End Point (AREP) associated with the transmission and reception of its process data.

Cyclic process data is further addressed by slot number. One slot is the granularity of the position dependent mapping of the cyclic data fields. A station may occupy more than one slot. The slots belonging to an AREP are identified by the range of slots beginning with the station number and with a length equal to the number of occupied slots as configured by the FAL user.

4.2.3 Transmission methods

The Type 18 AL implements a master/slave type architecture. Only a master is able to initiate transmissions. Slave devices respond to transmissions from the master. The access method employed is scanning. A scan cycle is one where the master device transmits data to, and receives data from, all the slaves connected to it. The particulars of the transmission methods are described by the Type 18 Application layer protocol specification.

4.2.4 Process data structures

Symbols (RX, RY, RWr, and RWw) are used throughout the Type 18 specifications to refer to types of cyclic data registers which are used to buffer process data for transmission and reception.

In addition to cyclic data, some AR types support acyclic message transmissions, sometimes named *transient data* transmissions by some industry users.

The type of data supported by an FAL is indicated by the level of process data support which is specified with the nomenclature described in Table 2.

Table 2 – Process data support level

Process data support level	Data type supported	Type 18 industry users Alias terminology
A	bit-oriented i/o data	Remote i/o station
B	A + word-oriented i.o data	Remote device station
C	B + acyclic messaging	Intelligent device station

5 Data type ASE

5.1 General

An overview of the data type ASE and the relationships between data types is provided in IEC/TR 61158-1:2010, 10.1.

5.2 Formal definition of data type objects

The template used to describe the data type class in this clause is detailed in IEC/TR 61158-1:2010, 10.2. This includes the specific ASE structure and the definition of its attributes.

5.3 FAL defined data types

5.3.1 Fixed length types

5.3.1.1 Boolean types

5.3.1.1.1 Boolean

CLASS: Data type
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 and FALSE.

5.3.1.2 Bitstring types

5.3.1.2.1 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

5.3.1.2.2 Octet

This data type is the same as Bitstring8.

5.3.1.2.3 BitString16

CLASS: Data type
ATTRIBUTES:

1	Data type Numeric Identifier	=	23
2	Data type Name	=	Bitstring16
3	Format	=	FIXED LENGTH
5.1	Octet Length	=	2

5.3.1.2.4 Word

This data type is the same as Bitstring16.

5.3.1.2.5 BitString32

CLASS: Data type
ATTRIBUTES:

1	Data type Numeric Identifier	=	24
2	Data type Name	=	Bitstring32
3	Format	=	FIXED LENGTH
5.1	Octet Length	=	4

5.3.1.3 Numeric types

5.3.1.3.1 Floating Point types

5.3.1.3.1.1 Float32

CLASS: Data type
ATTRIBUTES:

1	Data type Numeric Identifier	=	8

2	Data type Name	=	Float32
4	Format	=	FIXED LENGTH
4.1	Octet Length	=	4

This type has a length of four octets. The format for Float32 is that defined by IEC 60559 as single precision.

5.3.1.3.1.2 float

This data type is the same as Float32.

5.3.1.3.1.3 Float64

CLASS: **Data type**
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 IEC 60559 as double precision.

5.3.1.3.1.4 double

This data type is the same as Float64.

5.3.1.3.2 Integer types

5.3.1.3.2.1 Integer8

CLASS: **Data type**
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 char

This data type is the same as Integer8.

5.3.1.3.2.3 Integer16

CLASS: **Data type**
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.

5.3.1.3.2.4 short

This data type is the same as Integer16.

5.3.1.3.2.5 Integer32

CLASS: **Data type**
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.

5.3.1.3.2.6 long

This data type is the same as Integer32.

5.3.1.3.3 Unsigned types

5.3.1.3.3.1 Unsigned8

CLASS: **Data type**
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 unsigned char

This data type is the same as Unsigned8.

5.3.1.3.3.3 Unsigned16

CLASS: **Data type**
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 unsigned short

This data type is the same as Unsigned16.

5.3.1.3.3.5 Unsigned32

CLASS: **Data type**
ATTRIBUTES:

1	Data type Numeric Identifier	=	7
2	Data type Name	=	Unsigned32
3	Format	=	FIXED LENGTH
4.1	Octet Length	=	4

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 four octets.

5.3.1.3.3.6 unsigned long

This data type is the same as Unsigned32.

5.4 Data type ASE service specification

There are no operational services defined for the type object.