IEC 61158-6-21

Edition 2.0 2019-06

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Industrial communication networks – Fieldbus specifications – Part 6-21: Application layer protocol specification – Type 21 elements

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IEC 61158-6-21:2019-06(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 25.040.40; 35.100.70; 35.110

ISBN 978-2-8322-7013-4

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Part 6-21: Application layer protocol specification – Type 21 elements

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Attention is drawn to the fact that the use of the associated protocol type is restricted by its intellectual-property-right holders. In all cases, the commitment to limited release of intellectual-property-rights made by the holders of those rights permits a layer protocol type to be used with other layer protocols of the same type, or in other type combinations explicitly authorized by its intellectual-property-right holders.

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

International Standard IEC 61158-6-21 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 2010. This edition constitutes a technical revision.

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

- added WriteAndRead service;
- miscellaneous editorial corrections.

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

FDIS	Report on voting
65C/948/FDIS	65C/956/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- withdrawn;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.

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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 protocol provides the application service by making use of the services available from the data-link or other immediately lower layer. The primary aim of this document is to provide a set of rules for communication expressed in terms of the procedures to be carried out by peer application entities (AEs) at the time of communication. These rules for communication are intended to provide a sound basis for development in order to serve a variety of purposes:

- as a guide for implementers and designers;
- for use in the testing and procurement of equipment;
- as part of an agreement for the admission of systems into the open systems environment;
- as a refinement to the understanding of time-critical communications within OSI.

This document is concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices. By using this document together with other standards positioned within the OSI or fieldbus reference models, otherwise incompatible systems may work together in any combination.

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-21: Application layer protocol specification – Type 21 elements

1 Scope

1.1 General

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 61158-1.

This International Standard contains material specific to the Type 21 communication protocol.

1.2 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.

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This document provides common elements for basic time-critical and non-time-critical messaging communications between application programs in an automation environment, as well as material specific to Type 21. The term "time-critical" is used to represent the presence of a time-window, within which one or more specified actions must be completed with some defined level of certainty. Failure to complete specified actions within the required time risks the failure of the applications requesting the actions, with attendant risk to equipment, plant, and possibly human life.

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This document defines interactions between remote applications. It also defines the externally visible behavior provided by the Type 21 application layer in terms of:

a) the formal abstract syntax defining the application layer protocol data units (APDUs) conveyed between communicating application entities;
b) the transfer syntax defining encoding rules that are applied to the APDUs;
c) the application context state machine defining the application service behavior visible between communicating application entities;
d) the application relationship state machines defining the communication behavior visible between communicating application entities.

The purpose of this document is to:

a) describe the wire-representation of the service primitives defined in IEC 61158-5-21;
b) describe the externally visible behavior associated with their transfer.

This document defines the protocol of the Type 21 application layer in conformance with the OSI Basic Reference Model (ISO/IEC 7498) and the OSI application layer structure (ISO/IEC 9545).

1.3 Specifications

The principal objective of this document is to specify the syntax and behavior of the application layer protocol that conveys the Type 21 application layer services.

A secondary objective is to provide migration paths from previously existing industrial communications protocols.

1.4 Conformance

This document does not restrict individual implementations or products, nor does it constrain the implementations of application layer entities in industrial automation systems. Conformance is achieved through implementation of this application layer protocol specification.

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 61158-3-21:2019, *Industrial communication networks – Fieldbus specifications – Part 3-21: Data-link layer service definition – Type 21 elements*

IEC 61158-4-21:2019, *Industrial communication networks – Fieldbus specifications – Part 4-21: Data-link layer protocol specification – Type 21 elements*

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IEC 61158-5-21:2019, *Industrial communication networks – Fieldbus specifications – Part 5-21: Application layer service definition – Type 21 elements*

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ISO/IEC 7498-1, *Information technology – Open Systems Interconnection – Basic Reference Model: 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 10731, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*

ISO/IEC 9899, *Information technology – Programming Languages – C*

IEEE 754-2008, *IEEE Standard for Binary 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 Terms and definitions from other ISO/IEC standards

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

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

a) abstract syntax
b) presentation context

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3.1.3 ISO/IEC 8824-1 terms

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

a) object identifier
b) type

3.1.4 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

3.2 Other terms and definitions

3.2.1
application
function or data structure for which data are consumed or produced

3.2.2
application objects
multiple object classes that manage and provide a runtime exchange of messages across the network and within the network device

3.2.3
application process
part of a distributed application on a network, which is located on one device and addressed unambiguously

3.2.4
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”). Application process object definitions may 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 create and delete application objects and their corresponding definitions dynamically.

3.2.5
application process object class
class of application process objects defined in terms of the set of their network-accessible attributes and services

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3.2.6
application relationship
cooperative association between two or more application-entity-invocations for the purpose of exchange of information and coordination of their joint operation

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

3.2.7
application relationship application service element
application-service-element that provides the exclusive means for establishing and terminating all application relationships

3.2.8
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.

3.2.9
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.

3.2.10
behavior
indication of how an object responds to particular events

3.2.11
channel
single physical or logical link of an input or output application object of a server to the process

3.2.12
class
set of objects, all of which represent the same type 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.

3.2.13
class attributes
attribute shared by all objects within the same class

3.2.14
class code
unique identifier assigned to each object class

3.2.15
class-specific service
service defined by a particular object class to perform a required function that is not performed by a common service

Note 1 to entry: A class-specific object is unique to the object class that defines it.

3.2.16
client
a) object that uses the services of another (server) object to perform a task
b) initiator of a message to which a server reacts

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3.2.17
consume
act of receiving data from a producer

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3.2.18
consumer
node or sink that receives data from a producer

3.2.19
consuming application
application that consumes data

3.2.20
conveyance path
unidirectional flow of APDUs across an application relationship

3.2.21
cyclic
repetitive in a regular manner

3.2.22
data consistency
means for coherent transmission and access of the input- or output-data object between and within client and server

3.2.23
device
physical hardware connected to the link

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