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Industrial communication networks – Fieldbus specifications – Part 6-10: Application layer protocol specification – Type 10 elements

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-10: Application layer protocol specification – Type 10 elements

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

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

a) integration of system redundancy basic functionality;
b) integration of dynamic reconfiguration basic functionality;
c) integration of reporting system basic functionality;
d) integration of asset management basic functionality;e) integration of media redundancy ring interconnection basic functionality.

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- withdrawn;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.

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

IMPORTANT – The 'color inside' logo on the cover page of this publication indicates that it contains colors which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a color printer.

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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 admittance 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.

NOTE Attention is drawn to the fact that use of the associated protocol type(s) is restricted by its (their) intellectual-property-right holder(s). In all cases, the commitment to limited release of intellectual-property-rights made by the holder(s) of those rights permits a particular data-link layer protocol type to be used with physical layer and application layer protocols in type combinations as specified explicitly in the IEC 61784 series. Use of the protocol type(s) in other combinations may require permission of their respective intellectual-property-right holder(s).

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning Type 10 elements and possibly other types given in this document as follows:

The following patent rights for Type 10 have been announced by [SI]:

Publication	Title
WO 02/043336	System and method for parallel transfer of real-time critical and non-real-time critical data via switchable data networks, particularly Ethernet
WO 02/076033	Synchronous clocked communication system with decentralized input/output modules and methods for integrating decentralized input/output modules in such a system
WO 03/028258	Method for synchronizing nodes of a communication system
WO 03/028259	Communications system and method for synchronizing a communications cycle
WO 04/030284	Method for permanent redundant transmission of data telegrams in communication systems
EP 1558002	Method for assigning an IP address to a device
EP 1318630	Matrices for controlling the device specific data transfer rates on a field bus

IEC takes no position concerning the evidence, validity and scope of these patent rights.

The holder of these patent rights has assured the IEC that he/she is willing to negotiate licences either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of these patent rights is registered with IEC. Information may be obtained from:

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[SI]: Siemens AG
LC TE IP&IT

Otto-Hahn-Ring 6
D-81739 Munich
Germany

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

ISO (www.iso.org/patents) and IEC (http://www.iec.ch/tctools/patent_decl.htm) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the data bases for the most up to date information concerning patents.

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-10: Application layer protocol specification – Type 10 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 10 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 behavior provided by the Type 10 fieldbus application layer in terms of:

a) the abstract syntax defining the application layer protocol data units conveyed between communicating application entities,

b) the transfer syntax defining the application layer protocol data units conveyed between communicating application entities,

c) the application context state machine defining the application service behavior visible between communicating application entities, and

d) the application relationship state machines defining the communication behavior visible between communicating application entities.

The purpose of this document is to define the protocol provided to:

a) define the wire-representation of the service primitives defined in IEC 61158-5-10 and

b) define the externally visible behavior associated with their transfer.

This document specifies the protocol of the Type 10 fieldbus application layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498-1) and the OSI Application Layer Structure (ISO/IEC 9545).

1.2 Specifications

The principal objective of this document is to specify the syntax and behavior of the application layer protocol that conveys the application layer services defined in IEC 61158-5-10.

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 protocols standardized in IEC 61158-6.

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.

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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.

IEC 61131-9, *Programmable controllers – Part 9: Single-drop digital communication interface for small sensors and actuators (SDCI)*

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

IEC 61158-2, *Industrial communication networks – Fieldbus specifications – Part 2: Physical layer specification and service definition*

IEC 61158-5-10:2019, *Industrial communication networks – Fieldbus specifications – Application layer service definition – Type 10 elements*

IEC 61158-6-3:2019, *Industrial communication networks – Fieldbus specifications – Part 6-3: Application layer protocol specification – Type 3 elements*

IEC 62439-2, *Industrial communication networks – High availability automation networks – Part 2: Media Redundancy Protocol (MRP)*

ISO/IEC 646:1991, *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 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 9834-8, *Information technology – Procedures for the operation of object identifier registration authorities – Part 8: Generation of universally unique identifiers (UUIDs) and their use in object identifiers*

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 60559:2011, *Information technology – Microprocessor Systems – Floating-Point arithmetic*

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ISO 8601, *Data elements and interchange formats – Information interchange – Representation of dates and times*

IEEE Std 802, *IEEE Standard for Local and metropolitan area networks: Overview and Architecture,* available at http://www.ieee.org [viewed 2018-09-27]

IEEE Std 802.1AB:2016, *IEEE Standard for Local and metropolitan area networks: Station and Media Access Control Connectivity Discovery*, available at http://www.ieee.org [viewed 2018-09-27]

IEEE Std 802.1AC, *IEEE Standard for Local and metropolitan area networks – Media Access Control (MAC) Service definition*, available at http://www.ieee.org [viewed 2018-09-27]

IEEE Std 802.1AS, *IEEE standard for Local and metropolitan area networks – Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks*, available at http://www.ieee.org [viewed 2018-09-27]

IEEE Std 802.1Q-2018, *IEEE Standard for Local and metropolitan area networks – Bridges and Bridged Networks*, available at http://www.ieee.org [viewed 2018-09-27]

IEEE Std 802.3, *IEEE Standard for Ethernet*, available at http://www.ieee.org [viewed 2018-09-27]

IEEE Std 802.11, *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications,* available at http://www.ieee.org [viewed 2018-09-27]

IEEE Std 802.15.1, *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 15.1: Wireless medium access control (MAC) and physical layer (PHY) specifications for wireless personal area networks (WPANs),* available at http://www.ieee.org [viewed 2018-09-27]

IETF RFC 768, *User Datagram Protocol*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 791, *Internet Protocol*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 792*, Internet Control Message Protocol*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 826, *An Ethernet Address Resolution Protocol or Converting Network Protocol Addresses to 48.bit Ethernet Address for Transmission on Ethernet Hardware*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 950, *Internet Standard Subnetting Procedure*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 1034, *Domain names – Concepts and Facilities*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 1213, *Management Information Base for Network Management of TCP/IP-based internets: MIB-II;* available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 2131, *Dynamic Host Configuration Protocol*; available at http://www.ietf.org [viewed 2018-09-27]

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IETF RFC 2132, *DHCP Options and BOOTP Vendor Extensions*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 2236, *Internet Group Management Protocol, Version 2*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 2365, *Administratively Scoped IP Multicast*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 2474, *Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers;* available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 2674, *Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering and Virtual LAN Extensions*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 2863, *The Interfaces Group MIB*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 3418, *Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 3621, *Power Ethernet MIB*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 4361, *Node-specific Client Identifiers for Dynamic Host Configuration Protocol Version Four (DHCPv4)*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 4363, *Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering, and Virtual LAN Extensions*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 4604, *Using Internet Group Management Protocol Version 3 (IGMPv3) and Multicast Listener Discovery Protocol Version 2 (MLDv2) for Source-Specific Multicast,* available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 4632, *Classless Inter-domain Routing (CIDR): The Internet Address Assignment and Aggregation Plan*, available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 4836, *Definitions of Managed Objects for IEEE Std 802.3 Medium Attachment Units (MAUs)*, available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 5227*, IPv4 Address Conflict Detection*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 5890, *Internationalized Domain Names for Applications (IDNA): Definitions and Document Framework*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 5905, *Network Time Protocol Version 4: Protocol and Algorithms Specification*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 6151, *Updated Security Considerations for the MD5 Message-Digest and the HMAC-MD5 Algorithms*; available at http://www.ietf.org [viewed 2018-09-27]

IETF RFC 6890, *Special-Purpose IP Address Registries*; available at http://www.ietf.org [viewed 2018-09-27]

The Open Group, *Publication C706, Technical standard DCE1.1: Remote Procedure Call,* available at <http://www.opengroup.org/onlinepubs/9629399/toc.htm> [viewed 2018-09-27]

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3 Terms, definitions, abbreviated terms, symbols and conventions

For the purposes of this document, the following terms, definitions, symbols, abbreviated terms 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 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 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

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3.2 Terms and definitions for decentralized periphery

3.2.1
alarm
activation of an event that shows a critical state

3.2.2
alarm ack
acknowledgment of an event that shows a critical state

3.2.3
alarm data object
object(s) which represent critical states referenced by device/API/slot/subslot/alarm type

3.2.4
allocate
take a resource from a common area and assign that resource for the exclusive use of a specific entity

3.2.5
application
function or data structure for which data is consumed or produced

3.2.6
application layer interoperability
capability of application entities to perform coordinated and cooperative operations using the services of the FAL

3.2.7
application objects
multiple object classes that manage and provide a run time exchange of PDUs across the network and within the network device

3.2.8
application process
part of a distributed application on a network, which is located on one device and unambiguously addressed

3.2.9
application process identifier
distinguishes multiple application processes used in a device

3.2.10
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 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 dynamically create and delete application objects and their corresponding definitions.

3.2.11
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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3.2.12
application relationship
cooperative association between two or more application-entity-invocations for the purpose of exchange of information and coordination of their joint operation. This relationship is activated either by the exchange of application-protocol-data-units or as a result of preconfiguration activities

3.2.13
application relationship application service element
application-service-element that provides the exclusive means for establishing and terminating all application relationships

3.2.14
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.

3.2.15
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.

3.2.16
backup
status of the IO AR, which indicates that it is in the standby state

Note 1 to entry: An IO AR needs to be established to enter state backup.

3.2.17
behavior
indication of how an object responds to particular events

3.2.18
channel
representation of a single physical or logical link of an input or output application object of a server to the process in order to support addressing of diagnosis information

Note 1 to entry: The channel typically represents a single connector or clamp as a real interface of a module or submodule. This reference is used to identify points of failure within diagnosis PDUs.

3.2.19
channel diagnosis
information concerning a specific element of an input or output application object, provided for maintenance purposes

EXAMPLE Line break

3.2.20
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.

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3.2.21
class attributes
attribute that is shared by all objects within the same class

3.2.22
class code
unique identifier assigned to each object class

3.2.23
class specific service
service defined by a particular object class to perform a required function which is not performed by a common service

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

3.2.24
clear
status of the IO controller, which indicates that the control algorithm is currently not running

3.2.25
client
a) object which uses the services of another (server) object to perform a task

b) initiator of a PDU to which a server reacts

3.2.26
common profile
collection of device independent information and functionality providing consistency between all devices

3.2.27
communication data object
object(s) which is(are) parameter(s) of communication relationships and referenced by device/ slot/ subslot/ index

3.2.28
configuration check
comparison of the expected IO Data object structuring of the client with the real IO Data object structuring to the server in the startup phase

3.2.29
configuration fault
unacceptable difference between the expected IO Data object structuring and the real IO Data object structuring, as detected by the server

3.2.30
configuration identifier
representation of a portion of IO Data of a single input- and/or output-module of a server

3.2.31
consume
act of receiving data from a provider

3.2.32
consumer
node or sink receiving data from a provider

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