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Edition 2.0 2014-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Industrial communication networks – Fieldbus specifications – Part 6-4: Application layer protocol specification – Type 4 elements

Réseaux de communication industriels – Spécifications des bus de terrain – Partie 6-4: Spécification du protocole de la couche application – Eléments de type 4

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CONTENTS

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-4: Application layer protocol specification – Type 4 elements

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

International Standard IEC 61158-6-4 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 an technical revision.

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

a) editorial improvements;

b) editorial corrections.

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

FDIS	Report on voting
65C/764/FDIS	65C/774/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 the parts of the IEC 61158 series, 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- withdrawn;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.

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

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-4: Application layer protocol specification – Type 4 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 standard 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 4 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 standard specifies interactions between remote applications and defines the externally visible behavior provided by the Type 4 fieldbus application layer in terms of

a) the formal abstract syntax defining the application layer protocol data units conveyed between communicating application entities;
b) the transfer syntax defining encoding rules that are applied to the application layer protocol data units;
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 standard is to define the protocol provided to

1) define the wire-representation of the service primitives defined in IEC 61158-5-4, and
2) define the externally visible behavior associated with their transfer.

This standard specifies the protocol of the Type 4 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 standard is to specify the syntax and behavior of the application layer protocol that conveys the application layer services defined in IEC 61158-5-4.

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 series.

1.3 Conformance

This standard do not specify individual implementations or products, nor do they constrain the implementations of application layer entities within industrial automation systems. Conformance is achieved through implementation of this application layer protocol specification.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 61158-3-4, *Industrial communication networks – Fieldbus specifications – Part 3-4: Data-link layer service definition – Type 4 elements*

IEC 61158-5-4, *Industrial communication networks – Fieldbus specifications – Part 5-4: Application layer service definition – Type 4 elements*

IEC 61158-6:2003, *Digital data communications for measurement and control – Fieldbus for use in industrial control systems – Part 6: Application layer protocol specification* [1]

IEC 61158-6 (all subparts), *Industrial communication networks – Fieldbus specifications – Part 6: Application layer protocol specification*

ISO/IEC 7498-1, *Information technology – Open Systems Interconnection – Basic Reference Model – Part1: 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 10731, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*

3 Terms, definitions, symbols, abbreviations and conventions

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

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:

[1] This standard has been superseded by the IEC 61158-6 series

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

3.1.5 Fieldbus data-link layer terms

For the purposes of this document, the following terms as defined in IEC 61158-3-4 and IEC 61158-4-4 apply.

a) DL-Time
b) DL-Scheduling-policy
c) DLCEP
d) DLC
e) DL-connection-oriented mode
f) DLPDU
g) DLSDU
h) DLSAP
i) network address

j) node address

k) node

3.2 Abbreviations and symbols

AE	Application Entity
AL	Application Layer
ALE	Application Layer Entity
APDU	Application Protocol Data Unit
AR	Application Relationship
AREP	Application Relationship End Point
ASE	Application Service Element
Cnf	Confirmation
DL-	(as a prefix) Data-link-
DLCEP	Data-link Connection End Point
DLL	Data-link Layer
DLE	Data-link Entity
DLM	Data-link-management
DLS	Data-link Service
DLSAP	Data-link Service Access Point
DLSDU	DL-service-data-unit
FME	FAL Management Entity
Ind	Indication
IP	Internet Protocol
PDU	Protocol Data Unit
Req	Request
Rsp	Response
SME	System Management Entity
.cnf	Confirm Primitive
.ind	Indication Primitive
.req	Request Primitive
.rsp	Response Primitive

3.3 Conventions

3.3.1 General concept

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: its class definitions, its services, and its protocol specification. The first two are contained in IEC 61158-5-4. The protocol specification for each of the ASEs is defined in this standard.

The class definitions define the attributes of the classes supported by each ASE. The attributes are accessible from instances of the class using the Management ASE services specified in IEC 61158-5-4 standard. The service specification defines the services that are provided by the ASE.

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

3.3.2 Conventions for state machines for Type 4

A state machine describes the state sequence of an entity and can be represented by a state transition diagram and/or a state table.

In a state transition diagram (Figure 1), the transition between two states represented by circles is illustrated by an arrow beside which the transition events or conditions are presented.

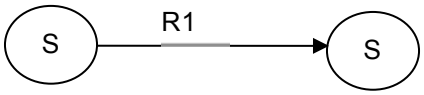

Figure 1 – State transition diagram

Table 1 – State machine description elements

#	Current state	Events or conditions that trigger this state transaction => action	Next state
Name of this transition	The current state to which this state transition applies	Events or conditions that trigger this state transaction. => The actions that are taken when the above events or conditions are met. The actions are always indented below events or conditions	The next state after the actions in this transition is taken

The conventions used in the state transition table (Table 1) are as follows.

:= Value of an item on the left is replaced by value of an item on the right. If an item on the right is a parameter, it comes from the primitive shown as an input event.

xxx A parameter name.

Example:

Identifier := reason
means value of a 'reason' parameter is assigned to a parameter called 'Identifier.'
"xxx" Indicates fixed value.

Example:

Identifier := "abc"
means value "abc" is assigned to a parameter named 'Identifier.'

= A logical condition to indicate an item on the left is equal to an item on the right.
< A logical condition to indicate an item on the left is less than the item on the right.
> A logical condition to indicate an item on the left is greater than the item on the right.
<> A logical condition to indicate an item on the left is not equal to an item on the right.
&& Logical "AND"
|| Logical "OR"

Service.req represents a Request Primitive; Service.req{} indicates that a request primitive is sent;

Service.ind represents an Indication Primitive; Service.ind{} indicates that an Indication Primitive is received;

Service.rsp represents a Response Primitive; Service.rsp{} indicates that a Response Primitive is sent;

Service.cnf represents a Confirm Primitive; Service.cnf{} indicates that a Confirm Primitive is received.

4 FAL syntax description

4.1 FAL-AR PDU abstract syntax

4.1.1 General

The information stored in an APDU depends on whether the APDU holds a request or a response. The role of the state machine that encodes the APDU (the FSPM) determines how the APDU is encoded.

APDUs always consist of an APDU header and an APDU body. In response APDUs the APDU body may be empty.

4.1.2 Abstract syntax of APDU header

Table 2 defines the contents of the APDU header.

Table 2 – APDU header

Field name	Subfield name	Possible values	Constraint (present if)	Comment
ControlStatus	Instruction	Errorcode Write Read And Or Test-And-Set Segmented Read Segmented Write		
ControlStatus	Errorcode	Described in Figure 3 to Figure 5	ControlStatus.Instruction = Errorcode	
ControlStatus	Addressing method	Variable Object Flat	ControlStatus.Instruction <> Errorcode	
ControlStatus	ActualDataError	NoActualError ActualError	ControlStatus.Instruction <> Errorcode	Used by the responding user application to indicate, that an actual error may affect the accessed Variable Object
ControlStatus	HistoricalDataError	NoHistoricalError HistoricalError	ControlStatus.Instruction <> Errorcode	Used by the responding user application to indicate, that an error may have affected the accessed Variable Object
DataFieldFormat	Offset/Attribute	No Offset/Attribute Offset/Attribute		Indicates, whether the APDU Body holds an Offset/Attribute field
DataFieldFormat	Variable Identifier Format	Simple Complex	APDU is a request APDU	Indicates the format of the Variable Identifier in a request APDU