



IEC 61158-5-9

Edition 1.0 2007-12

INTERNATIONAL STANDARD

**Industrial communication networks – Fieldbus specifications –
Part 5-9: Application layer service definition – Type 9 elements**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE **XE**

ICS 35.100.70; 25.040.40

ISBN 2-8318-9457-3

CONTENTS

FOREWORD	5
INTRODUCTION	7
1 Scope	8
1.1 Overview	8
1.2 Specifications	9
1.3 Conformance	9
2 Normative references	9
3 Terms, definitions, symbols, abbreviations and conventions	10
3.1 ISO/IEC 7498-1 terms	10
3.2 ISO/IEC 8822 terms	10
3.3 ISO/IEC 9545 terms	10
3.4 ISO/IEC 8824 terms	10
3.5 IEC/TR 61158-1 terms	10
3.6 Type 9 fieldbus application-layer specific definitions	14
3.7 Abbreviations and symbols	14
3.8 Conventions	15
4 Concepts	18
5 Data type ASE	18
5.1 Overview	18
5.2 Formal definition of data type objects	20
5.3 FAL defined data types	22
5.4 Data type ASE service specification	25
5.5 Summary of data types	25
6 Communication model specification	26
6.1 Concepts	26
6.2 Common parameters	26
6.3 ASEs	26
6.4 ARs	114
6.5 Summary of classes	118
6.6 Permitted services by AREP role	118
Bibliography	120
Figure 1 – Data type class hierarchy	19
Figure 2 – VFD model	26
Figure 3 – Abstract model of an automation system (VFD)	27
Figure 4 – Source OD/remote OD	33
Figure 5 – Put OD state machine	46
Figure 6 – Transaction object state machine	52
Figure 7 – Context test of two features-supported with different bitstring length	60
Figure 8 – Overview of event	79
Figure 9 – Event state machine	85
Figure 10 – Domain genericdownload/download state machine (server)	99
Figure 11 – Domain upload state machine (server)	101

Figure 12 – State diagram.....	112
Table 1 – Data type summary	25
Table 2 – Logical status	28
Table 3 – Status.....	29
Table 4 – Unsolicited status	30
Table 5 – Identify	31
Table 6 – Structure of the object dictionary	34
Table 7 – Structure of the static list of types	34
Table 8 – Structure of the static object dictionary.....	34
Table 9 – Structure of the dynamic list of variable lists.....	35
Table 10 – Structure of the dynamic list of program invocations	35
Table 11 – Empty object dictionary	39
Table 12 – Get OD service parameters	42
Table 13 – Initiate put OD service parameters	44
Table 14 – Put OD service parameters.....	45
Table 15 – Terminate put OD service parameters	46
Table 16 – Put OD state transitions.....	48
Table 17 – Attribute FMS features supported	50
Table 18 – Transaction object state transitions	53
Table 19 – Initiate service parameters	54
Table 20 – Failure reasons	55
Table 21 – Abort service parameters.....	56
Table 22 – User abort reasons	57
Table 23 – APO ASE abort reasons	57
Table 24 – Reject service parameters	58
Table 25 – Reject APDU reasons	58
Table 26 – Compatibility of the local context to the remote context	59
Table 27 – Unconfirmed send service parameters.....	62
Table 28 – Confirmed send service parameters	63
Table 29 – AR-Abort service parameters.....	63
Table 30 – Compel service parameters	64
Table 31 – Get buffered message service parameters.....	65
Table 32 – AR-Status service parameters	66
Table 33 – Simple variable access group membership	67
Table 34 – Simple variable access rights membership	67
Table 35 – Array variable access group membership	69
Table 36 – Array variable access rights membership.....	70
Table 37 – Variable list access group membership.....	71
Table 38 – Variable list access rights membership.....	72
Table 39 – Read service parameters.....	74
Table 40 – Write service parameters.....	75
Table 41 – Information report service parameters	76

Table 42 – Define variable list service parameters	77
Table 43 – Delete variable list service parameters	78
Table 44 – Event access group membership	80
Table 45 – Event access rights membership	81
Table 46 – Event notification service parameters	82
Table 47 – Acknowledge event notification service parameters	83
Table 48 – Alter event condition monitoring service parameters	84
Table 49 – Event state transitions	85
Table 50 – Domain access group membership	86
Table 51 – Domain access rights membership	86
Table 52 – GenericInitiateDownloadSequence	88
Table 53 – GenericDownloadSegment	89
Table 54 – GenericTerminateDownloadSequence	90
Table 55 – InitiateDownloadSequence	91
Table 56 – DownloadSegment	92
Table 57 – TerminateDownloadSequence	93
Table 58 – RequestDomainDownload.....	94
Table 59 – InitiateUploadSequence.....	95
Table 60 – UploadSegment.....	96
Table 61 – TerminateUploadSequence	97
Table 62 – RequestDomainUpload	98
Table 63 – Domain genericDownload/download state machine (server)	99
Table 64 – Domain upload state machine (server)	101
Table 65 – Program invocation access group membership	103
Table 66 – Program invocation access group membership	103
Table 67 – Create program invocation service parameters	105
Table 68 – Delete program invocation service parameters	106
Table 69 – Start service parameters	107
Table 70 – Stop service parameters	108
Table 71 – Resume service parameters	109
Table 72 – Reset service parameters	110
Table 73 – Kill service parameters	111
Table 74 – Program invocation state machine	113
Table 75 – Class summary.....	118
Table 76 – Services by AREP role	118

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
FIELD BUS SPECIFICATIONS –****Part 5-9: Application layer service definition – Type 9 elements**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

NOTE Use of some of the associated protocol types is restricted by their 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 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 various protocol types in other combinations may require permission from their respective intellectual-property-right holders.

International Standard IEC 61158-5-9 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This first edition and its companion parts of the IEC 61158-5 subseries cancel and replace IEC 61158-5:2003. This edition of this part constitutes an editorial revision.

This edition of IEC 61158-5 includes the following significant changes from the previous edition:

- a) deletion of the former Type 6 fieldbus, and the former Type 1 fieldbus application layer, for lack of market relevance;

- b) addition of new types of fieldbuses;
- c) partition of part 5 of the third edition into multiple parts numbered -5-2, -5-3, ...

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

FDIS	Report on voting
65C/475/FDIS	65C/486/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.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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 The revision of this standard will be synchronized with the other parts of the IEC 61158 series.

The 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.

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 5-9: Application layer service definition – Type 9 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 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 9 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 defines in an abstract way the externally visible service provided by the different Types of 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 standard is to define the services provided to

- 1) the FAL user at the boundary between the user and the Application Layer of the Fieldbus Reference Model, and
- 2) Systems Management at the boundary between the Application Layer and Systems Management of the Fieldbus Reference Model.

This standard specifies the structure and services of the IEC fieldbus Application Layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498) 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 standard 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.

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 standard 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 Type 9 application layer services as defined in this standard.

2 Normative references

The following referenced standards 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 standard (including any amendments) applies.

IEC 60559, *Binary Floating-point Arithmetic for Microprocessor Systems*

IEC/TR 61158-1 (Ed.2.0), *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 – Part 1: The Basic Model*

ISO/IEC 7498-3, *Information technology – Open Systems Interconnection – Basic Reference Model – Part 3: Naming and addressing*

ISO/IEC 9545, *Information technology – Open Systems Interconnection – Application Layer structure*