



IEC 61158-5-2

Edition 1.0 2007-12

INTERNATIONAL STANDARD

**Industrial communication networks – Fieldbus specifications –
Part 5-2: Application layer service definition – Type 2 elements**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE **XJ**

ICS 25.040.40; 35.100.70

ISBN 2-8318-9444-1

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.....	11
3.4 ISO/IEC 8824 terms.....	11
3.5 Type 2 fieldbus data-link layer terms.....	11
3.6 Type 2 fieldbus application-layer specific definitions.....	11
3.7 Type 2 abbreviations and symbols.....	19
3.8 Conventions.....	20
4 Common concepts.....	22
5 Data type ASE.....	23
5.1 General.....	23
5.2 Formal definition of data type objects.....	23
5.3 FAL defined data types.....	23
5.4 Data type ASE service specification.....	33
6 Communication model specification.....	34
6.1 Concepts.....	34
6.2 ASEs.....	42
6.3 ARs.....	148
6.4 Summary of FAL classes.....	185
6.5 Permitted FAL services by AR type.....	186
Bibliography.....	188
Figure 1 – Overview of ASEs and object classes.....	36
Figure 2 – Addressing format using MAC, class, instance and attribute IDs.....	36
Figure 3 – Identity object state transition diagram.....	54
Figure 4 – Static Assembly state transition diagram.....	59
Figure 5 – Dynamic Assembly state transition diagram.....	60
Figure 6 – Typical timing relationships for acknowledged data production.....	69
Figure 7 – Example of a COS system with two acking devices.....	69
Figure 8 – Message flow in COS connection – one Connection object, one consumer.....	69
Figure 9 – Message flow in COS connection – multiple consumers.....	70
Figure 10 – CPF2 time synchronization offset clock model.....	77
Figure 11 – CPF2 time synchronization system with offset clock model.....	78
Figure 12 – CPF2 time synchronization group startup sequence.....	81
Figure 13 – Example of Find_Next_Object_Instance service.....	106

Figure 14 – Transmission trigger timer	142
Figure 15 – Inactivity watchdog timer	143
Figure 16 – Using tools for configuration	144
Figure 17 – Production inhibit timer	145
Figure 18 – Context of transport services within the connection model.....	151
Figure 19 – Application-to-application view of data transfer	151
Figure 20 – Data flow diagram for a link producer	152
Figure 21 – Data flow diagram for a link consumer.....	153
Figure 22 – Triggers	154
Figure 23 – Binding transport instances to the producer and consumer of a transport connection that does not have a reverse data path	155
Figure 24 – Binding transport instances to the producers and consumers of a transport connection that does have a reverse data path	155
Figure 25 – Binding transport instances to the producer and consumers of a multipoint connection when the transport connection does not have a reverse data path	156
Figure 26 – Binding transport instances to the producers and consumers of a multipoint connection when the transport connection does have reverse data paths	156
Table 1 – Valid IANA MIB printer codes for character set selection	32
Table 2 – Common elements	39
Table 3 – ST language elements.....	40
Table 4 – Type conversion operations.....	40
Table 5 – Values of implementation-dependent parameters	41
Table 6 – Extensions to IEC 61131-3	42
Table 7 – Identity object state event matrix.....	55
Table 8 – Static Assembly state event matrix.....	59
Table 9 – Dynamic Assembly state event matrix	60
Table 10 – Message Router object Forward_Open parameters	63
Table 11 – Acknowledge Handler object state event matrix.....	66
Table 12 – Producing I/O application object state event matrix	67
Table 13 – Qos values	81
Table 14 – Status codes	84
Table 15 – Get_Attribute_All service parameters	86
Table 16 – Set_Attribute_All service parameters.....	87
Table 17 – Get_Attribute_List service parameters.....	89
Table 18 – Set_Attribute_List service parameters	91
Table 19 – Reset service parameters.....	93
Table 20 – Start service parameters	95
Table 21 – Stop service parameters.....	97
Table 22 – Create service parameters	98
Table 23 – Delete service parameters.....	100
Table 24 – Get_Attribute_Single service parameters.....	101
Table 25 – Set_Attribute_Single service parameters	103
Table 26 – Find_Next_Object_Instance service parameters	104

Table 27 – NOP service parameters	107
Table 28 – Apply_Attributes service parameters	108
Table 29 – Save service parameters	110
Table 30 – Restore service parameters.....	111
Table 31 – Group_Sync service parameters.....	113
Table 32 – Add_AckData_Path service parameters.....	115
Table 33 – Remove_AckData_Path service parameters	116
Table 34 – Initialize service parameters	117
Table 35 – Management_Message service parameters.....	119
Table 36 – CM_Open service parameters	127
Table 37 – CM_Close service parameters.....	129
Table 38 – CM_Unconnected_Send service parameters	130
Table 39 – CM_Get_Connection_Data service parameters	132
Table 40 – CM_Search_Connection_Data service parameters	133
Table 41 – CM_Get_Connection_Data service parameters	134
Table 42 – I/O Connection object attribute access	139
Table 43 –Bridged Connection object attribute access	140
Table 44 – Explicit messaging object attribute access.....	141
Table 45 – Connection_Bind service parameters	146
Table 46 – Service_Name service parameters	147
Table 47 – How production trigger, transport class, and CM_RPI determine when data is produced.....	150
Table 48 – Transport classes	161
Table 49 – UCMM_Create service parameters	178
Table 50 – UCMM_Delete service parameters	179
Table 51 – UCMM_Write service parameters	180
Table 52 – UCMM_Abort service parameters	181
Table 53 – TR_Write service parameters	182
Table 54 – TR_Trigger service parameters	183
Table 55 – TR_Packet_arrived service parameters	183
Table 56 – TR_Ack_received service parameters.....	184
Table 57 – TR_Verify service parameters	184
Table 58 – TR_Status_updated service parameters	185
Table 59 – FAL class summary	186
Table 60 – FAL services by AR type	187

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
FIELD BUS SPECIFICATIONS –****Part 5-2: Application layer service definition – Type 2 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 61158-5-2 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 a technical revision. This part and its Type 2 companion parts also cancel and replace IEC/PAS 62413.

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

- a) deletion of the former Type 6 fieldbus 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 5-2: Application layer service definition – Type 2 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 2 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 Type 2 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 Type 2 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, 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 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 2 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 61131-3:2003, *Programmable controllers – Part 3: Programming languages*

IEC 61158-4-2, *Industrial communication networks – Fieldbus specifications – Part 4-2: Data-link layer protocol specification – Type 2 elements*

IEC 61158-6-2, *Industrial communication networks – Fieldbus specifications – Part 6-2: Application layer protocol specification – Type 2 elements*

IEC 61588:2004¹, *Precision clock synchronization protocol for networked measurement and control systems*

IEC 61784-3-2, *Industrial communications networks – Profiles – Part 3-2: Functional safety fieldbuses – Additional specifications for CPF 2*

¹ Compliance with future editions of this standard will need checking.

ISO/IEC 646, *Information technology – ISO 7-bit coded character set for information interchange*

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 8822, *Information technology – Open Systems Interconnection – Presentation service definition*

ISO/IEC 8824, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*

ISO/IEC 8859-1, *Information technology – 8-bit single-byte coded graphic character sets – Part 1: Latin alphabet No. 1*

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

ISO/IEC 10646-1, *Information technology – Universal Multiple-Octet Coded Character Set (UCS) – Architecture and Basic Multilingual Plane*

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

ISO 11898:1993², *Road vehicles – Interchange of digital information – Controller area network (CAN) for high-speed communication*

² A newer edition of this standard has been published, but only the cited edition applies.