

INTERNATIONAL STANDARD

**Industrial communication networks – Fieldbus specifications –
Part 5-12: Application layer service definition – Type 12 elements**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2010 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00



IEC 61158-5-12

Edition 2.0 2010-08

INTERNATIONAL STANDARD

**Industrial communication networks – Fieldbus specifications –
Part 5-12: Application layer service definition – Type 12 elements**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE

XE

ICS 25.04.40; 35.100.70; 35.110

ISBN 978-2-88912-108-3

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 Reference model terms and definitions.....	10
3.2 Service convention terms and definitions.....	10
3.3 Application layer and data-link service terms and definitions.....	11
3.4 Common symbols and abbreviations.....	15
3.5 Conventions.....	16
4 Concepts.....	17
4.1 Common concepts.....	17
4.2 Type specific concepts.....	17
5 Data type ASE.....	25
5.1 General.....	25
5.2 Formal definition of data type objects.....	25
5.3 FAL defined data types.....	25
5.4 Data type ASE service specification.....	33
6 Communication model specification.....	33
6.1 ASEs.....	33
6.2 AR.....	106
Bibliography.....	117
Figure 1 – Producer consumer model.....	19
Figure 2 – Client server model.....	19
Figure 3 – Server triggered invocation.....	19
Figure 4 – Slave reference model.....	20
Figure 5 – Simple slave device.....	21
Figure 6 – Complex slave device.....	22
Figure 7 – Master functional overview.....	23
Figure 8 – Process output data sequence.....	34
Figure 9 – Process input data sequence.....	35
Figure 10 – CoE server model.....	52
Figure 11 – Successful single SDO-Download sequence.....	57
Figure 12 – Unsuccessful single SDO-Download sequence.....	58
Figure 13 – Successful segmented SDO-Download sequence.....	58
Figure 14 – Successful single SDO-Upload sequence.....	59
Figure 15 – Unsuccessful single SDO-Upload sequence.....	60
Figure 16 – Successful segmented SDO-Upload sequence.....	60
Figure 17 – SDO information sequence.....	61

Figure 18 – Emergency service	62
Figure 19 – Command sequence	63
Figure 20 – PDO mapping	64
Figure 21 – Sync manager PDO assignment.....	65
Figure 22 – RxPDO service	66
Figure 23 – TxPDO service	67
Figure 24 – RxPDO remote transmission sequence	68
Figure 25 – TxPDO remote transmission sequence	68
Figure 26 – EoE sequence	88
Figure 27 – FoE read sequence with success	95
Figure 28 – FoE read sequence with error	96
Figure 29 – FoE write sequence with success.....	96
Figure 30 – FoE write sequence with error.....	97
Figure 31 – FoE write sequence with busy.....	97
Figure 32 – Successful AL control sequence	107
Figure 33 – Unsuccessful AL control sequence.....	108
Figure 34 – AL state changed sequence	109
Table 1 – Process output data	37
Table 2 – Process input data	38
Table 3 – Update process input data	39
Table 4 – SII read	47
Table 5 – SII write	48
Table 6 – SII reload.....	49
Table 7 – Allocation of SDO areas	53
Table 8 – SDO download expedited	72
Table 9 – SDO download normal	73
Table 10 – Download SDO segment	74
Table 11 – SDO upload expedited	75
Table 12 – SDO upload normal.....	76
Table 13 – Upload SDO segment	77
Table 14 – Abort SDO transfer	77
Table 15 – Get OD list.....	78
Table 16 – OD list segment	79
Table 17 – Get object description	80
Table 18 – Get entry description.....	81
Table 19 – Object entry segment.....	83
Table 20 – Emergency	84
Table 21 – RxPDO	85
Table 22 – TxPDO	85
Table 23 – RxPDO remote transmission	86
Table 24 – TxPDO remote transmission	86
Table 25 – Initiate EoE	91

Table 26 – EoE fragment.....	92
Table 27 – Set IP parameter.....	93
Table 28 – Set address filter.....	94
Table 29 – FoE read.....	99
Table 30 – FoE write	99
Table 31 – FoE data.....	100
Table 32 – FoE ack	100
Table 33 – FoE busy	101
Table 34 – FoE error	101
Table 35 – MBX read	103
Table 36 – MBX write	104
Table 37 – MBX read upd.....	105
Table 38 – AL management and ESM service primitives	106
Table 39 – AL control	115
Table 40 – AL state change.....	116

This document is a preview generated by EVS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
FIELDBUS SPECIFICATIONS –****Part 5-12: Application layer service definition –
Type 12 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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 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 1 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 profile parts. Use of the various protocol types in other combinations may require permission of their respective intellectual-property-right holders.

International Standard IEC 61158-5-12 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 a technical revision.

The main changes with respect to the previous edition are listed below:

- bug fixes and

- editorial improvements.

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

FDIS	Report on voting
65C/606/FDIS	65C/620/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 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.

NOTE 2 The revision of this standard will be synchronized with the other parts of the IEC 61158 series.

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.

This document is a preview generated by EVS

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 5-12: Application layer service definition – Type 12 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 12 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

- a) the FAL user at the boundary between the user and the Application Layer of the Fieldbus Reference Model, and
- b) 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, 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 any given Type of application layer services as defined in this standard.

2 Normative references

The following referenced documents 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 document (including any amendments) applies.

IEC 61131-3, *Programmable controllers – Part 3: Programming languages*

IEC 61158-3-12, *Industrial communication networks – Fieldbus specifications – Part 3-12: Data-link layer service definition – Type 12 elements*

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

ISO/IEC 8802-3, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO/IEC 10646, *Information technology – Universal Multiple-Octet Coded Character Set (UCS)*

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

IEEE 802.1D, *IEEE standard for local and metropolitan area networks – Media access control (MAC) Bridges*; available at <<http://www.ieee.org>>

IETF RFC 791, *Internet Protocol darpa internet program protocol specification*; available at <<http://www.ietf.org>>

3 Terms, definitions, symbols, abbreviations and conventions

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

3.1 Reference model terms and definitions

This standard is based in part on the concepts developed in ISO/IEC 7498-1 and ISO/IEC 7498-3, and makes use of the following terms defined therein:

3.1.1 correspondent (N)-entities	[ISO/IEC 7498-1]
correspondent AL-entities (N=7)	
3.1.2 (N)-entity	[ISO/IEC 7498-1]
AL-entity (N=7)	
3.1.3 (N)-layer	[ISO/IEC 7498-1]
AL-layer (N=7)	
3.1.4 layer-management	[ISO/IEC 7498-1]
3.1.5 peer-entities	[ISO/IEC 7498-1]
3.1.6 primitive name	[ISO/IEC 7498-3]
3.1.7 AL-protocol	[ISO/IEC 7498-1]
3.1.8 AL-protocol-data-unit	[ISO/IEC 7498-1]
3.1.9 reset	[ISO/IEC 7498-1]
3.1.10 routing	[ISO/IEC 7498-1]
3.1.11 segmenting	[ISO/IEC 7498-1]
3.1.12 (N)-service	[ISO/IEC 7498-1]
AL-service (N=7)	
3.1.13 AL-service-data-unit	[ISO/IEC 7498-1]
3.1.14 AL-simplex-transmission	[ISO/IEC 7498-1]
3.1.15 AL-subsystem	[ISO/IEC 7498-1]
3.1.16 systems-management	[ISO/IEC 7498-1]
3.1.17 AL-user-data	[ISO/IEC 7498-1]

3.2 Service convention terms and definitions

This standard also makes use of the following terms defined in ISO/IEC 10731 as they apply to the data-link layer: