

INTERNATIONAL STANDARD

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





THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2019 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

Tel.: +41 22 919 02 11
info@iec.ch
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

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 It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.



IEC 61158-5-12

Edition 4.0 2019-04

INTERNATIONAL STANDARD

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 25.040.40; 35.100.70; 35.110

ISBN 978-2-8322-6747-9

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
1.1 General.....	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	11
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
4.2.1 Operating principle	17
4.2.2 Communication model overview.....	18
4.2.3 Application layer element description.....	18
4.2.4 Slave reference model.....	20
4.2.5 Master reference model	22
5 Data type ASE.....	24
5.1 General.....	24
5.2 Formal definition of data type objects.....	24
5.3 FAL defined data types	24
5.3.1 Fixed length types	24
5.3.2 String types	32
5.3.3 GUID Types.....	33
5.4 Data type ASE service specification.....	33
6 Communication model specification.....	33
6.1 ASEs	33
6.1.1 Process data ASE.....	33
6.1.2 SII ASE	40
6.1.3 Isochronous ASE.....	49
6.1.4 CoE ASE	52
6.1.5 EoE ASE	85
6.1.6 FoE ASE.....	94
6.1.7 MBX ASE	100
6.2 AR.....	105
6.2.1 Overview	105
6.2.2 AR control class specification	110
6.2.3 AR service specification	114
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	59
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	64
Figure 22 – RxPDO service	66
Figure 23 – TxPDO service	66
Figure 24 – RxPDO remote transmission sequence	67
Figure 25 – TxPDO remote transmission sequence	67
Figure 26 – EoE sequence	87
Figure 27 – FoE read sequence with success	94
Figure 28 – FoE read sequence with error	95
Figure 29 – FoE write sequence with success	95
Figure 30 – FoE write sequence with error	96
Figure 31 – FoE write sequence with busy	96
Figure 32 – Successful AL control sequence	106
Figure 33 – Unsuccessful AL control sequence	107
Figure 34 – AL state changed sequence	108
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	71
Table 9 – SDO download normal	72
Table 10 – Download SDO segment	73

Table 11 – SDO upload expedited.....	74
Table 12 – SDO upload normal.....	75
Table 13 – Upload SDO segment.....	76
Table 14 – Abort SDO transfer.....	76
Table 15 – Get OD list.....	77
Table 16 – OD list segment.....	78
Table 17 – Get object description.....	79
Table 18 – Get entry description.....	80
Table 19 – Object entry segment.....	82
Table 20 – Emergency.....	83
Table 21 – RxPDO.....	84
Table 22 – TxPDO.....	84
Table 23 – RxPDO remote transmission.....	85
Table 24 – TxPDO remote transmission.....	85
Table 25 – Initiate EoE.....	90
Table 26 – EoE fragment.....	91
Table 27 – Set IP parameter.....	92
Table 28 – Set address filter.....	93
Table 29 – FoE read.....	98
Table 30 – FoE write.....	98
Table 31 – FoE data.....	99
Table 32 – FoE ack.....	99
Table 33 – FoE busy.....	100
Table 34 – FoE error.....	100
Table 35 – MBX read.....	102
Table 36 – MBX write.....	103
Table 37 – MBX read upd.....	104
Table 38 – AL management and ESM service primitives.....	105
Table 39 – AL control.....	115
Table 40 – AL state change.....	116

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.

Attention is drawn to the fact that the use of the associated protocol type is restricted by its 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 layer protocol type to be used with other layer protocols of the same type, or in other type combinations explicitly authorized by its intellectual-property-right holders.

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

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 fourth edition cancels and replaces the third edition published in 2014. This edition constitutes a technical revision.

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

- Technical corrections; and
- Editorial improvements for clarification.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
65C/947/FDIS	65C/950/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.

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 service is provided by the application protocol making use of the services available from the data-link or other immediately lower layer. This document 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 document is a conceptual architectural service, independent of administrative and implementation divisions.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

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