IEC 61158-6-25

Edition 1.0 2019-06

INTERNATIONAL STANDARD

This document is a preview generated by EVS

colour inside

Industrial communication networks – Fieldbus specifications – Part 6-25: Application layer protocol specification – Type 25 elements

IEC 61158-6-25:2019-06(en)

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 Varembé
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 It also gives information on projects, replaced and withdrawn publications.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.

This document is a preview generated by EVS

IEC 61158-6-25

Edition 1.0 2019-06

INTERNATIONAL STANDARD

This document is a preview generated by EVS

colour inside

Industrial communication networks – Fieldbus specifications – Part 6-25: Application layer protocol specification – Type 25 elements

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 25.040.40; 35.100.70; 35.110

ISBN 978-2-8322-7015-8

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

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 7
INTRODUCTION 9
1 Scope 10
1.1 General 10
1.2 Specification 11
1.3 Conformance 11
2 Normative references 11
3 Terms, definitions, symbols, abbreviations and conventions 12
3.1 Reference model terms and definitions 12
3.1.1 ISO/IEC 7498-1 terms 12
3.1.2 ISO/IEC 8822 terms 12
3.1.3 ISO/IEC 9545 terms 12
3.1.4 ISO/IEC 8824-1 terms 13
3.2 Additional Type 25 terms and definitions 13
3.3 Symbols and abbreviations 15
3.4 Conventions 16
3.4.1 General conventions 16
3.4.2 Conventions for class definitions 16
3.4.3 Conventions for bit description in octets 16
3.4.4 Conventions for state machine descriptions 17
4 FAL syntax description 18
4.1 FAL PDU type S abstract syntax 18
4.1.1 Basic abstract syntax 18
4.2 FAL PDU type N abstract syntax 22
4.2.1 Basic abstract syntax 22
4.2.2 CyclicData-PDU 22
4.2.3 MulticastData-PDU 23
4.2.4 PtoPData-PDU 23
4.2.5 Aliveinfo-PDU 23
4.2.6 Aliveinfo6-PDU 23
4.2.7 Inq-PDU 24
4.2.8 Ninq-PDU 24
4.2.9 Reply-PDU 24
4.2.10 RetransEnq-PDU 24
4.2.11 RetransConfirm-PDU 24
4.2.12 RetransNak-PDU 25
4.3 Data type assignments for type S 25
4.4 Data type assignments for type N 25
5 FAL transfer syntax 26
5.1 Encoding rules 26
5.1.1 Unsigned encoding 26
5.1.2 Octet string encoding 27
5.1.3 SEQUENCE encoding 27
5.2 FALPDU type S elements encoding 27
5.2.1 RCL_header 27
5.2.2 RHE-PDU 28

This document is a preview generated by EVS

5.2.3 LCC-PDU 30
5.2.4 LCA-PDU 30
5.2.5 LCN-PDU 31
5.2.6 LNA-PDU 32
5.2.7 SCR-PDU 32
5.2.8 Cyclic_S-PDU 32
5.2.9 Cyclic_header 33
5.2.10 Control-PDU 33
5.2.11 RMTCTL-PDU 33
5.2.12 INFO-PDU 34
5.3 FALPDU type N elements encoding 35
5.3.1 General 35
5.3.2 FALAR-N Header 35
5.3.3 CyclicData-PDU 49
5.3.4 MulticastData-PDU 50
5.3.5 PtoP Data-PDU 50
5.3.6 Aliveinfo-PDU 50
5.3.7 Aliveinfo6-PDU 53
5.3.8 Inq-PDU 54
5.3.9 Ninq-PDU 55
5.3.10 Reply-PDU 55
5.3.11 RetransEnq-PDU 56
5.3.12 RetransConfirm-PDU 56
5.3.13 RetransNak-PDU 57
6 Structure of the FAL protocol state machine 58
7 FAL service protocol machine (FSPM) 58
7.1 Overview 58
7.2 FSPM type S 58
7.2.1 Overview 58
7.2.2 Interface of cyclic communication to FAL users 59
7.2.3 State machine of FSPM 61
7.3 FSPM type N 62
7.3.1 Overview 62
7.3.2 FSPM 63
8 Application relationship protocol machine (ARPM) 65
8.1 ARPM type S 65
8.1.1 Overview 65
8.1.2 Cyclic control 66
8.1.3 Remote control 70
8.1.4 RCL communication control 75
8.1.5 RT communication control 79
8.2 ARPM type N 83
8.2.1 Overview 83
8.2.2 General control 83
8.2.3 Cyclic transmission control 85
8.2.4 Acyclic transmission control 90
8.2.5 RT communication control 105
9 DLL mapping protocol machine (DMPM) 121

This document is a preview generated by EVS

9.1 DMPM type S 121
9.2 DMPM type N 122
9.2.1 General 122
9.2.2 Communication port in transport layer 122
9.2.3 Quality of Service 122
Bibliography 124

Figure 1 – Bit description in octets 16
Figure 2 – hd_sa 35
Figure 3 – hd_da 36
Figure 4 – Valid sequence number for reception message 40
Figure 5 – hd_m_ctl 40
Figure 6 – Valid reception packet sequence number 44
Figure 7 – Node-list 55
Figure 8 – Relationships between protocol machines 58
Figure 9 – Structure of FSPM type S 59
Figure 10 – Shared memory allocation in type S network 61
Figure 11 – Structure of FSPM type N 63
Figure 12 – Structure of ARPM type S 66
Figure 13 – Sequence of cyclic communication 67
Figure 14 – The primitives for cyclic control 67
Figure 15 – The primitives for Remote control 70
Figure 16 – The primitives for RCL communication control 75
Figure 17 – The primitives for RT communication control 80
Figure 18 – Structure of ARPM type N 83
Figure 19 – Primitives of Cyclic transmission control 85
Figure 20 – Primitives of acyclic transmission control 91
Figure 21 – DSCP format 123
Figure 22 – IEEE 802.1Q tag frame format 123

Table 1 – State transition descriptions 17
Table 2 – Descriptions of state machine elements 17
Table 3 – Conventions used in state machine 17
Table 4 – Frame Class 27
Table 5 – DA_STaddress – DA_STaddress 27
Table 6 – DA_MACaddress 27
Table 7 – CMD field format 28
Table 8 – Send Direction 28
Table 9 – RHE ReceiveStatus 29
Table 10 – Physical Linkdown 29
Table 11 – RHE_pattern 1~4 30
Table 12 – LCC-Kind 30
Table 13 – RCL Status 31
Table 14 – hd_h_type 35

This document is a preview generated by EVS

Table 15 – Usage of Mgn or Lnn 37
Table 16 – Detailed conditions for sequence number check of reception message 39
Table 17 – Valid bits of hd_m_ctl 40
Table 18 – Specified TCD 41
Table 19 – hd_pkind 42
Table 20 – PDU with an effective hd_pseq 42
Table 21 – Detailed conditions for sequence number check of reception packet (Multicast communication with retransmission) 44
Table 22 – Detailed conditions for packet sequence number check 45
Table 23 – Relation between message transmission/reception 46
Table 24 – hd_mode 46
Table 25 – Message priority level 46
Table 26 – Value of α 47
Table 27 – Example of header information for a UDP message fragmentation 47
Table 28 – Example of header information for a TCP message fragmentation 47
Table 29 – inqid_inq_sa value 48
Table 30 – inqid_tr_adr value 48
Table 31 – inqid_inq_seq value 49
Table 32 – Relationship between inqid_id_seq and inqid_tr_adr 49
Table 33 – Type of an alive-message 51
Table 34 – Type of an alive-message protocol 51
Table 35 – Time of each al_mode 52
Table 36 – Status change of tasks 52
Table 37 – Change of tasks content 52
Table 38 – The threshold of transmission factor 60
Table 39 – Example of the traffic control configuration menu 60
Table 40 – Cyclic data state table 61
Table 41 – Acyclic data state table 62
Table 42 – Cyclic data state table 64
Table 43 – Acyclic data state table 64
Table 44 – Cyclic control state table 68
Table 45 – Cyclic control functions 69
Table 46 – Cyclic control variables 70
Table 47 – Remote control state table 71
Table 48 – Remote control functions 74
Table 49 – Remote control variables 75
Table 50 – RCL communication control state table 76
Table 51 – RCL communication control functions 77
Table 52 – RCL communication control variables 79
Table 53 – RT communication control state table 80
Table 54 – RT communication control functions 82
Table 55 – RT communication control variables 82
Table 56 – Cyclic transmission control state table 86

This document is a preview generated by EVS

Table 57 – Cyclic transmission control functions 88
Table 58 – Cyclic transmission control variables 90
Table 59 – Acyclic transmission control state table 91
Table 60 – Acyclic transmission control functions 101
Table 61 – Acyclic transmission control variables 104
Table 62 – RT communication control state table 105
Table 63 – RT communication control functions 116
Table 64 – RT communication control variables 120
Table 65 – ARPM to DL mapping 122
Table 66 – Assignment policy of communication ports 122
Table 67 – Default DSCP, IEEE 802.1D and IEEE 802.1Q priority mapping 123

This document is a preview generated by EVS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-25: Application layer protocol specification – Type 25 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.

International Standard IEC 61158-6-25 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

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

FDIS	Report on voting
65C/948/FDIS	65C/956/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 the ISO/IEC Directives, Part 2.

This document is a preview generated by EVS

A list of all parts in the IEC 61158 series, published under the general title *Industrial communication networks – Fieldbus specifications*, can be found on the IEC website.

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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

This document is a preview generated by EVS

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

This document is a preview generated by EVS

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-25: Application layer protocol specification – Type 25 elements

This document is a preview generated by EVS

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 International 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 25 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 document defines in an abstract way the externally visible behavior provided by the different Types of the fieldbus Application Layer in terms of:

a) the abstract syntax defining the application layer protocol data units conveyed between communicating application entities,

b) the transfer syntax defining the application layer protocol data units conveyed between communicating application entities,

c) the application context state machine defining the application service behavior visible between communicating application entities; and

d) the application relationship state machines defining the communication behavior visible between communicating application entities.

The purpose of this document is to define the protocol provided to:

a) define the wire-representation of the service primitives defined in IEC 61158-5-25, and

b) define the externally visible behavior associated with their transfer.

This document specifies the protocol of the IEC fieldbus Application Layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498-1) 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 document to provide access to the FAL to control certain aspects of its operation.

1.2 Specification

The principal objective of this document is to specify the syntax and behavior of the application layer protocol that conveys the application layer services defined in IEC 61158-5-25. 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 subparts of IEC 61158-6.

1.3 Conformance

This document 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 the application layer service definition standard. Instead, conformance is achieved through implementation of this application layer protocol specification.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

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 61158-3-25:2019, *Industrial communication networks – Fieldbus specifications – Part 3-25: Data-link layer service definition – Type 25 elements*

IEC 61158-5-25:2019, *Industrial communication networks – Fieldbus specifications – Part 5-25: Application layer service definition – Type 25 elements*

ISO/IEC 7498-1, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

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

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

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

ISO/IEC/IEEE 8802-3, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet*

IEEE Std 802.1D, *IEEE Standard for Local and metropolitan area networks – Media access Control (MAC) Bridges*; available at http://www.ieee.org [viewed 2018-09-17]

This document is a preview generated by EVS

IEEE Std 802.1Q, *IEEE Standard for Local and metropolitan area networks – Bridges and Bridged Networks*; available at http://www.ieee.org [viewed 2018-09-17]

IETF RFC 768, *User Datagram Protocol*; available at http://www.ietf.org> [viewed 2018-09-17]

IETF RFC 791, *Internet Protocol*; available at http://www.ietf.org> [viewed 2018-09-17]

3 Terms, definitions, symbols, abbreviations and conventions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Reference model terms and definitions

3.1.1 ISO/IEC 7498-1 terms

For the purposes of this document, the following terms given in ISO/IEC 7498-1 apply:

application entity;
application process;
application protocol data unit;
application service element;
application entity invocation;
application process invocation;
application transaction;
real open system;
transfer syntax.

3.1.2 ISO/IEC 8822 terms

For the purposes of this document, the following terms given in ISO/IEC 8822 apply:

a) abstract syntax;
presentation context.

3.1.3 ISO/IEC 9545 terms

For the purposes of this document, the following terms given in ISO/IEC 9545 apply:

a) application-association;
application-context;
application context name;
application-entity-invocation;
application-entity-type;
application-process-invocation;
application-process-type;
application-service-element;

This document is a preview generated by EVS