

INTERNATIONAL STANDARD

**Industrial communication networks – Fieldbus specifications –
Part 5-23: Application layer service definition – Type 23 elements**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2023 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 Secretariat
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 It also gives information on projects, replaced and withdrawn publications.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.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.



IEC 61158-5-23

Edition 3.0 2023-03

INTERNATIONAL STANDARD

**Industrial communication networks – Fieldbus specifications –
Part 5-23: Application layer service definition – Type 23 elements**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 25.040.40; 35.100.70; 35.110

ISBN 978-2-8322-6579-6

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

CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	9
1.1 General.....	9
1.2 Specifications	10
1.3 Conformance	10
2 Normative references	10
3 Terms, definitions, symbols, abbreviated terms and conventions	11
3.1 Referenced terms and definitions.....	11
3.1.1 ISO/IEC 7498-1 terms.....	11
3.1.2 ISO/IEC 8822 terms.....	11
3.1.3 IEC 61158-1 terms.....	11
3.2 Additional Type 23 terms and definitions.....	12
3.3 Symbols and abbreviated terms	14
3.4 Conventions.....	15
3.4.1 General conventions.....	15
3.4.2 Conventions for class definitions	16
3.4.3 Conventions for service definitions	17
4 Concept.....	18
5 Data type ASE.....	18
5.1 Overview.....	18
5.2 Fixed length types.....	19
5.2.1 Bitstring types.....	19
5.2.2 Numeric types	20
6 Communication model specification	24
6.1 Communication model.....	24
6.1.1 General	24
6.1.2 Cyclic model n:n	24
6.1.3 Cyclic model 1:n	25
6.1.4 Transient model.....	25
6.2 ASE	26
6.2.1 Overview type C	26
6.2.2 Overview type F.....	26
6.2.3 Cyclic data ASE type C.....	26
6.2.4 Cyclic data ASE type F	33
6.2.5 Acyclic data ASE type C	38
6.2.6 Acyclic data ASE type F	44
6.2.7 Management ASE.....	57
6.2.8 Synchronization ASE	60
6.2.9 Measurement ASE.....	61
6.2.10 Overview type T.....	62
6.2.11 Cyclic data ASE type T	63
6.2.12 Acyclic data ASE type T	65
6.2.13 Management ASE type T	73
6.2.14 Time sync data ASE type T.....	75
6.2.15 SLMP data ASE type T	77

6.3	AR type C	78
6.3.1	Overview	78
6.3.2	Connection Control	79
6.3.3	Cyclic transmission type C	83
6.3.4	Acyclic transmission type C	84
6.3.5	Common parameter dist.....	87
6.4	AR type F	92
6.4.1	Overview	92
6.4.2	Channel control	93
6.4.3	Cyclic transmission type F	100
6.4.4	Acyclic transmission type F.....	102
6.4.5	Parameter dist	105
6.4.6	Synchronous trigger.....	108
6.4.7	Measurement transmission	109
6.5	AR type T	111
6.5.1	Overview	111
6.5.2	Cyclic transmission type T	112
6.5.3	Acyclic transmission type T.....	113
6.5.4	Channel control type T.....	114
6.5.5	Time sync control	117
6.5.6	IP trans control	118
6.5.7	Handler.....	119
	Bibliography.....	120
	Figure 1 – Cyclic model (n:n type distributed shared memory, unconfirmed push model)	25
	Figure 2 – Cyclic model (1:n type distributed shared memory, unconfirmed push model)	25
	Figure 3 – Transient model (Client server model).....	25
	Figure 4 – Transient model (Push model).....	26
	Figure 5 – Structure of ASE type C of FAL Type 23	26
	Figure 6 – Structure of ASE type F of FAL Type 23.....	26
	Figure 7 – Structure of ASE type T of FAL Type 23.....	63
	Figure 8 – Structure of AR type C	78
	Figure 9 – Structure of AR type F.....	92
	Figure 10 – Structure of AR type T.....	111
	Table 1 – Ld service parameters	28
	Table 2 – Set service parameters.....	28
	Table 3 – Reset service parameters.....	28
	Table 4 – Read service parameters.....	29
	Table 5 – Write service parameters.....	29
	Table 6 – Ld service parameters	30
	Table 7 – Set service parameters.....	31
	Table 8 – Reset service parameters.....	31
	Table 9 – Read service parameters.....	32
	Table 10 – Write service parameters.....	32
	Table 11 – Ld service parameters	34

Table 12 – Set service parameters.....	35
Table 13 – Reset service parameters.....	35
Table 14 – Read service parameters.....	36
Table 15 – Write service parameters.....	36
Table 16 – Get memory access info service parameters	39
Table 17 – Run service parameters.....	40
Table 18 – Stop service parameters.....	41
Table 19 – Read memory service parameters	42
Table 20 – Write memory service parameters	43
Table 21 – Get memory access info service parameters	45
Table 22 – Run service parameters.....	46
Table 23 – Stop service parameters.....	47
Table 24 – Read memory service parameters	48
Table 25 – Write memory service parameters	49
Table 26 – Vendor command service parameters.....	50
Table 27 – Distribute node info service parameters.....	51
Table 28 – Get statistics service parameters.....	52
Table 29 – Get node info detail service parameters	54
Table 30 – AC data service parameters	56
Table 31 – AC data ND service parameters	57
Table 32 – Get attribute service parameters	58
Table 33 – Set attribute service parameters.....	59
Table 34 – Synchronization trigger service parameters.....	60
Table 35 – Start measurement service parameters	61
Table 36 – Get offset service parameters.....	62
Table 37 – Read service parameters.....	64
Table 38 – Write service parameters.....	64
Table 39 – Priority service parameters.....	66
Table 40 – Detection service parameters	67
Table 41 – Detection Ack service parameters	68
Table 42 – Test data service parameters	70
Table 43 – Test data ack service parameters.....	71
Table 44 – Acyclic data rsv service parameters	72
Table 45 – Acyclic data nrsv service parameters.....	73
Table 46 – Get attribute service parameters	74
Table 47 – Set attribute service parameters.....	75
Table 48 – TimeSyncMng service parameters.....	76
Table 49 – SLMP data service parameters.....	77
Table 50 – Control cyclic service parameters.....	82
Table 51 – CT Update service parameters	84
Table 52 – AC Send service parameters	85
Table 53 – AC Param send service parameters.....	87
Table 54 – CPD Set service parameters	92

Table 55 – Control cyclic service parameters	99
Table 56 – CT Update service parameters	101
Table 57 – AC Send service parameters	102
Table 58 – AC Send ND service parameters	104
Table 59 – Synchronous trigger internal service parameters	108
Table 60 – Measure send service parameters	109
Table 61 – MeasureAck send service parameters	110
Table 62 – Offset send service parameters	110
Table 63 – Update send service parameters	111
Table 64 – C Update service parameters	112
Table 65 – AC Update service parameters	114
Table 66 – Send cyclic service parameters	115
Table 67 – Send acyclic service parameters	116
Table 68 – TimeSync service parameters	117
Table 69 – SLMPSend service parameters	118

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
FIELDBUS SPECIFICATIONS –****Part 5-23: Application layer service definition –
Type 23 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 the IEC 61784-1 series and the IEC 61784-2 series.

IEC 61158-5-23 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation. It is an International Standard.

This third edition cancels and replaces the second edition published in 2019. This edition constitutes a technical revision.

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

- a) addition of Type T ASE (6.2.10 to 6.2.15).
- b) addition of Type T AR (6.5).

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

Draft	Report on voting
65C/1203/FDIS	65C/1244/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all the parts of 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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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 can 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 5-23: Application layer service definition – Type 23 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 23 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 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 that 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 7498-1) 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 Specifications

The principal objective of this document 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 document can 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 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 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 document.

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 the IEC 61784-1 series and the IEC 61784-2 series 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 61158-1:2023, *Industrial communication networks – Fieldbus specifications – Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series*

IEC 61158-6 (all parts), *Industrial communication networks – Fieldbus specifications – Part 6-X: Application layer protocol specification*

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: The Basic Model*

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

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

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

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

IEEE Std 802.1AS, *Standard for Local and Metropolitan Area Networks – Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks*

IEEE Std 1588, *Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems*

3 Terms, definitions, symbols, abbreviated terms and conventions

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

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

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

3.1 Referenced 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:

- a) application entity
- b) application process
- c) application protocol data unit
- d) application service element

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

3.1.3 IEC 61158-1 terms

For the purposes of this document, the following terms given in IEC 61158-1 apply:

- a) DLL mapping protocol machine
- b) fieldbus application layer
- c) FAL service protocol machine
- d) protocol data unit.