# IEC 61158-5-27

Edition 1.0 2023-03

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

## Industrial communication networks – Fieldbus specifications – Part 5-27: Application layer service definition – Type 27 elements

## Réseaux de communication industriels – Spécifications des bus de terrain – Partie 5-27: Définition des services de la couche application – Éléments de type 27



IEC 61158-5-27:2023-03(en-fr)



**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.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

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 It also gives information on projects, replaced and withdrawn publications.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

**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.

---

**A propos de l'IEC**
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

**A propos des publications IEC**
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

**Recherche de publications IEC - webstore.iec.ch/advsearchform**
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, …). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

**IEC Just Published - webstore.iec.ch/justpublished**
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

**Service Clients - webstore.iec.ch/csc**
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

**IEC Products & Services Portal - products.iec.ch**
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

**Electropedia - www.electropedia.org**
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

# IEC 61158-5-27

Edition 1.0 2023-03

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

## Industrial communication networks – Fieldbus specifications – Part 5-27: Application layer service definition – Type 27 elements

## Réseaux de communication industriels – Spécifications des bus de terrain – Partie 5-27: Définition des services de la couche application – Éléments de type 27

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 25.040

ISBN 978-2-8322-6582-6

**Warning! Make sure that you obtained this publication from an authorized distributor.**
**Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

® Registered trademark of the International Electrotechnical Commission
Marque déposée de la Commission Electrotechnique Internationale

# 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 9545 terms ..... 11
3.1.3 ISO/IEC 8824-1 terms ..... 11
3.1.4 Terms and definitions from ISO/IEC 10731 ..... 12
3.2 Additional terms and definitions ..... 12
3.3 Abbreviations and symbols ..... 17
3.4 Conventions ..... 18
3.4.1 Overview ..... 18
3.4.2 Conventions for class definitions ..... 19
3.4.3 Conventions for service definitions ..... 20
4 Concepts ..... 21
4.1 Common concepts ..... 21
4.2 Type specific concepts ..... 21
4.2.1 General ..... 21
4.2.2 Node type ..... 21
4.2.3 Basic system configuration ..... 22
4.2.4 Communication sequence overview ..... 22
4.2.5 Network initialization ..... 24
4.2.6 Multi control domain system ..... 24
4.2.7 Multiple transmission cycles ..... 24
4.2.8 Sync master switching ..... 24
4.2.9 TSN ..... 24
5 Data type ASE ..... 24
6 Communication model specifications ..... 25
6.1 Type specific concepts ..... 25
6.2 Overview ..... 25
6.3 FAL ASEs ..... 27
6.3.1 FSM ASE ..... 27
6.3.2 Field Device Control ASE ..... 60
6.3.3 Message ASE ..... 89
6.3.4 Event Management ASE ..... 103
6.4 FAL Ars ..... 107
6.4.1 AR model ..... 107
6.4.2 FSM AREP ..... 111
6.4.3 FDC AREP ..... 121
6.4.4 MSG AREP ..... 133
Bibliography ..... 140

Figure 1 – Transmission cycle with concurrent I/O data exchange ..... 22
Figure 2 – Transmission cycle with sequential I/O data exchange ..... 23
Figure 3 – Control domain transmission band ..... 23
Figure 4 – FAL ASE model of Type 27 ..... 27
Figure 5 – CDO (Communication Data Object) ..... 30
Figure 6 – AR model for field device control service ..... 110
Figure 7 – AR model for message service ..... 110
Figure 8 – MSG ARs between each APs ..... 111

Table 1 – AP type definition ..... 26
Table 2 – Support list of service for each class of FSM ASE ..... 29
Table 3 – Overall structure of CDO ..... 31
Table 4 – Node object categories ..... 31
Table 5 – Module object category ..... 31
Table 6 – List of node objects (object information) ..... 32
Table 7 – List of node objects (object status) ..... 33
Table 8 – List of node objects (control) ..... 34
Table 9 – List of node objects (configuration) ..... 34
Table 10 – List of module objects (configuration) ..... 41
Table 11 – FSM-Reset ..... 43
Table 12 – FSM-GetStatus ..... 43
Table 13 – FSM-SetContext ..... 44
Table 14 – FSM-GetContext ..... 45
Table 15 – FSM-GetTopology ..... 46
Table 16 – FSM-InformTopology ..... 47
Table 17 – FSM-ChangeAddress ..... 48
Table 18 – FSM-Start ..... 49
Table 19 – FSMUL-RESET ..... 51
Table 20 – FSMUL-SET-VALUE ..... 51
Table 21 – FSMUL-GET-VALUE ..... 52
Table 22 – FSMUL-START-NET ..... 53
Table 23 – FSMUL-DETECT ..... 54
Table 24 – FSMUL-RECOG ..... 55
Table 25 – FSUMUL-SW-TRANS-MODE ..... 55
Table 26 – FSMUL-MEAS-DELAY ..... 56
Table 27 – FSMUL-SW-EVD ..... 57
Table 28 – FSMUL-CONFIG ..... 58
Table 29 – FSMUL-START-SYNC ..... 59
Table 30 – FSMUL-CLR-ERR ..... 59
Table 31 – FSMUL-EVENT ..... 60
Table 32 – FSMUL error event primitive and parameters ..... 60
Table 33 – Support list of service for each class of FDC ASE ..... 61

Table 34 – FDC-Reset for master class ..... 64
Table 35 – FDC-Open for master class ..... 65
Table 36 – FDC-Enable for master class ..... 66
Table 37 – FDC-Connect for master class ..... 66
Table 38 – FDC-SyncSet for master class ..... 67
Table 39 – FDC-Disconnect for master class ..... 68
Table 40 – FDC-ResumeCycle for master class ..... 69
Table 41 – FDC-ComCycle for master class ..... 69
Table 42 – FDC-Command for master class ..... 70
Table 43 – FDC-DataExchange for master class ..... 71
Table 44 – FDC-Reset for slave class ..... 75
Table 45 – FDC-Open for slave class ..... 75
Table 46 – FDC-Enable for slave class ..... 76
Table 47 – FDC-Connect for slave class ..... 77
Table 48 – FDC-SyncSet for slave class ..... 78
Table 49 – FDC-Disconnect for slave class ..... 80
Table 50 – FDC-ResumeCycle for slave class ..... 80
Table 51 – FDC-ComCycle for slave class ..... 81
Table 52 – FDC-Command for slave class ..... 81
Table 53 – FDC-DataExchange for slave class ..... 83
Table 54 – CTC-WRITE-DATA ..... 85
Table 55 – CTC-READ-DATA ..... 86
Table 56 – CTC-SDA ..... 87
Table 57 – CTC-SDN ..... 88
Table 58 – CTC-EVENT ..... 89
Table 59 – Values of Event_ID for event service ..... 89
Table 60 – Support list of service for each class of Message ASE ..... 90
Table 61 – MSG-Reset for requester class ..... 91
Table 62 – MSG-Open for requester class ..... 92
Table 63 – MSG-Enable for requester class ..... 93
Table 64 – MSG-UserMessage for requester class ..... 93
Table 65 – MSG-OnewayMessage for requester class ..... 95
Table 66 – MSG-AbortTransaction for requester class ..... 97
Table 67 – MSG-Reset for responder class ..... 98
Table 68 – MSG-Open for responder class ..... 99
Table 69 – MSG-Enable for responder class ..... 99
Table 70 – MSG-UserMessage for responder class ..... 100
Table 71 – MSG-OnewayMessage for responder class ..... 102
Table 72 – MSG-AbortTransaction for responder class ..... 103
Table 73 – Support list of service for each class of Event Management ASE ..... 104
Table 74 – EVM-Reset ..... 105
Table 75 – EVM-Enable ..... 105
Table 76 – EVM-SyncEvent ..... 106

Table 77 – EVM-ReadNetClock ..... 106
Table 78 – Support list of service for each class of AR ASE ..... 108
Table 79 – AR-Reset for FSM AR class ..... 113
Table 80 – AR-Open for FSM AR class ..... 113
Table 81 – AR-Enable for FSM AR class ..... 114
Table 82 – AR-SendSync for FSM AR class ..... 115
Table 83 – AR-SendToken for FSM AR class ..... 116
Table 84 – AR-ReqSend for FSM AR class ..... 117
Table 85 – AR-SendDelay for FSM AR class ..... 118
Table 86 – AR-ReqCDO for FSM AR class ..... 119
Table 87 – AR-WriteCDO for FSM AR class ..... 120
Table 88 – AR-SendAsync for FSM AR class ..... 121
Table 89 – AR-Reset for FDC Master AR class ..... 124
Table 90 – AR-Open for FDC Master AR class ..... 124
Table 91 – AR-Enable for FDC Master AR class ..... 125
Table 92 – AR-CycleEvent for FDC Master AR class ..... 125
Table 93 – AR-StartComCycle for FDC Master AR class ..... 126
Table 94 – AR-ResetCycle for FDC Master AR class ..... 126
Table 95 – AR-SendCommand for FDC Master AR class ..... 127
Table 96 – AR-Reset for FDC Slave AR class ..... 130
Table 97 – AR-Open for FDC Slave AR class ..... 130
Table 98 – AR-Enable for FDC Slave AR class ..... 131
Table 99 – AR-CycleEvent for FDC Slave AR class ..... 131
Table 100 – AR-StartComCycle for FDC Slave AR class ..... 132
Table 101 – AR-ResetCycle for FDC Slave AR class ..... 132
Table 102 – AR-SendCommand for FDC Slave AR class ..... 133
Table 103 – AR-Reset for Message AR class ..... 135
Table 104 – AR-Open for Message AR class ..... 135
Table 105 – AR-Enable for Message AR class ..... 136
Table 106 – AR-SendMessage for Message AR class ..... 137
Table 107 – AR-ReceiveMessage for Message AR class ..... 138
Table 108 – AR-AbortMessage for Message AR class ..... 139

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

# INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

## Part 5-27: Application layer service definition – Type 27 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 61158-5-27 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation. It is an International Standard.

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

| Draft | Report on voting |
|---|---|
| 65C/1205/FDIS | 65C/1234/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 parts of the IEC 61158 series, 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 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 5-27: Application layer service definition – Type 27 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 27 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 fieldbus Application Layer in terms of

- an abstract model for defining application resources (objects) capable of being manipulated by users via the use of the FAL service,
- the primitive actions and events of the service,
- the parameters associated with each primitive action and event, and the form which they take, and
- the interrelationship between these actions and events, and their valid sequences.

The purpose of this document is to define the services provided to

- the FAL user at the boundary between the user and the Application Layer of the Fieldbus Reference Model, and
- 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 series.

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 document, including

- the sizes and octet ordering of various multi-octet service parameters, and
- 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 do they 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 fulfil 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 61158-6-27:2023, *Industrial communication networks – Fieldbus specifications – Part 6-27: Application layer protocol specification – Type 27 elements*

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

ISO/IEC 8824-1, *Information technology – Abstract Syntax Notation One (ASN.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 802-2014, *IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture*

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

## 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 terminology 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 as defined in ISO/IEC 7498-1 apply:

- abstract syntax;
- application-entity;
- application process;
- application protocol data unit;
- application-process-invocation;
- (N)-facility;
- (N)-function;
- correspondent-(N)-entities;
- presentation context;
- real system;
- transfer syntax.

#### 3.1.2 ISO/IEC 9545 terms

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

- application-association;
- application-context;
- application-entity-invocation;
- application-entity-type;
- application-service-element.

#### 3.1.3 ISO/IEC 8824-1 terms

For the purposes of this document, the following terms as defined in ISO/IEC 8824-1 apply:

- object identifier.

### 3.1.4 Terms and definitions from ISO/IEC 10731

For the purposes of this document, the following terms as defined in ISO/IEC 10731 apply:

- OSI-service-primitive; primitive;
- OSI-service-provider; provider;
- OSI-service-user; user.

## 3.2 Additional terms and definitions

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

**3.2.1**
**alarm**
field device status to tell that the device has detected a fatal problem to be solved and cannot continue normal working, through the field device control (FDC) service of the Type 27 fieldbus

Note 1 to entry: Any alarm statuses are latched and need some operations to be cleared.

Note 2 to entry: Alarms are classified into three groups; communication alarms, illegal-command-related ones, and application specific ones. But concrete definitions are dependent on implementation of each field device.

**3.2.2**
**application process object**
network representation of a specific aspect of an application process (AP), which is modelled as a network accessible object contained within an AP or within another APO

Note 1 to entry: Details are given in IEC 61158-1, 9.3.4.

**3.2.3**
**application process context**
**AP context**
shared knowledge or a common set of rules, governing communication of FAL application entities (AEs) and describing the permissible collective communications behavior between the AEs that are party to a specific set of application relationships (ARs)

Note 1 to entry: Data within AP context can be specified by the user in advance, by the option selected while the user uses a field bus management (FSM) service to read out the facility of peer AP, by the automatic negotiation function that the FSM system handles, etc. The method that is to be adopted depends on the specification of each implementation.

**3.2.4**
**application process type**
**AP type**
description of a classification of application processes (APs) in terms of a set of capabilities for FAL of the Type 27 fieldbus

Note 1 to entry: AP types are classified into three ones, C1 master AP, C2 master AP and slave AP, by their application roles in the fieldbus network, see 6.2.

**3.2.5**
**async command**
type of a command application protocol data unit (APDU) of the FDC service of the Type 27 FAL, which can be issued any time after the previous transaction without consideration of synchronization with the communication cycle

Note 1 to entry: Definitions, which command should be async one or not, are dependent on an application. They can be provided as a registered set of commands and responses or device profiles (see IEC 61158-6-27, 4.4 and Annex A).

**3.2.6**
**asynchronous communication**
state or a way of communication for the FDC service of the Type 27 FAL, in which a command can be issued any time after the previous transaction without consideration of synchronization with the communication cycle

Note 1 to entry: In this state, sync commands cannot be issued, but async commands can.

**3.2.7**
**attribute**
information or parameter contained in variable portions of an object

Note 1 to entry: Typically, they provide status information or govern the operation of an object. Attributes also affect the behavior of an object.

**3.2.8**
**C1 master**
AP type that has master facilities for the FDC service of the Type 27 FAL, or the device implementing that AP type

Note 1 to entry: Only one C1 master exists in a network of the Type 27 fieldbus.

**3.2.9**
**C2 master**
AP type that has only monitor facilities for the FDC service but requester facilities for message (MSG) service of the Type 27 FAL, or the device implementing that AP type

Note 1 to entry: Less than two C2 masters can exist in a network of the Type 27 fieldbus.

**3.2.10**
**command**
PDU issued by a requester or a master to make a responder or a slave execute some functions

**3.2.11**
**communication**
process to exchange information in a formal manner between two or more devices, users, APs or entities

**3.2.12**
**transfer**
process to convey a PDU from a sender to a receiver

**3.2.13**
**transmission**
process to send out and propagate electrical signals or encoded data

**3.2.14**
**communication cycle**
period of repetitive activities synchronized with the transmission cycle while the connection establishing for the FDC protocol of the Type 27 FAL

Note 1 to entry: Communication cycle can synchronize with a cycle multiplying the transmission cycle by a specified scaling factor.

**3.2.15**
**connection**
context or logical binding under specific conditions for the FDC protocol between a master object and a slave object for the Type 27 FAL

**3.2.16**
**cyclic**
repetitive in a regular manner

**3.2.17**
**cyclic communication**
transmission mode in which request PDUs and response PDUs are exchanged repetitively in the scheduled time slots synchronized with a transmission cycle for the lower layer protocol of the Type 27 fieldbus

Note 1 to entry: In the AL, the communication cycle arises from the transmission cycle in this mode.

**3.2.18**
**cycle scale counter**
counter to generate a communication cycle by means of scaling a primary cycle or a transmission cycle

**3.2.19**
**device ID**
part of "device information" to identify the device for a specific product type or model of the Type 27 fieldbus

**3.2.20**
**device information**
formatted and device-embedded information to characterize a device, which mainly consists of data for device model identification and device-profile specific parameters for the Type 27 fieldbus

**3.2.21**
**device profile**
collection of device model-common information and functionality providing consistency between different device models among the same kind of devices

**3.2.22**
**dual transfer**
transfer mode for the FDC protocol of the Type 27 FAL, in which a sender sends a same PDU twice a transaction and a receiver uses them to detect and recover a communication error such as data-corruption or data-loss in cyclic communication mode

**3.2.23**
**event driven communication**
transmission mode for the lower layer protocol of the Type 27 fieldbus in which a transaction of command-response-exchanging arises as user’s demands

Note 1 to entry: Both the transmission cycle and the communication cycle don’t arise in this mode.

**3.2.24**
**error**
abnormal condition or malfunction for communication or any other activities

**3.2.25**
**field device control service**
**FDC service**
time-critical communication service that handles a fixed length command data to control a field device and the corresponding feedback response data in a severe restriction on delay or jitter for the communication timing for the Type 27 FAL

**3.2.26**
**field device control protocol**
time-critical communication protocol that handles a fixed length command data to control a field device and the corresponding feedback response data in a severe restriction on delay or jitter for the communication timing for the Type 27 FAL

**3.2.27**
**master**
class or its instance object of FDC application service element (ASE) that plays a role of a command requester for the Type 27 FAL

**3.2.28**
**message service**
**MSG service**
communication service that handles the variable length data and doesn’t require a severe restriction on response time

**3.2.29**
**monitor**
class or its instance object of FDC ASE that plays a role of a watcher or subscriber of commands and response between other communication nodes for the Type 27 FAL

**3.2.30**
**monitor slave**
variant of slave AP type that has both slave class and monitor class for FDC ASE of the Type 27 FAL

**3.2.31**
**network clock**
synchronized and periodically running counter that each node in a same network has, which becomes an oscillation source of the transmission cycle

**3.2.32**
**protocol machine**
state machine that realizes the protocol as the main function of the entity in each layer

**3.2.33**
**requester**
class or its instance object of MSG ASE that plays a role of a command requester or sender for the Type 27 FAL

**3.2.34**
**responder**
class or its instance object of MSG ASE that plays a role of a command responder or receiver for the Type 27 FAL

**3.2.35**
**response**
PDU issued by a responder or a slave to inform a result or some status for the received command to a requester or a master

**3.2.36**
**service**
operation or process that an object performs upon request from another object

**3.2.37**
**single transfer**
normal transfer mode for the FDC protocol of the Type 27 FAL in which a sender sends a same PDU once a transaction

**3.2.38**
**slave AP**
AP type that has slave facilities for the FDC service of the Type 27 FAL, or the device implementing that AP type

**3.2.39**
**slave**
**FDC slave**
class or its instance object of FDC ASE that plays a role of a responder for the Type 27 FAL

**3.2.40**
**state machine**
logical automatic machine or automaton that has a finite number of states and handles state transition fired by an event as a trigger

**3.2.41**
**sync command**
type of command or APDU of the FDC service of the Type 27 FAL, which is issued at the synchronized timing with every communication cycle

Note 1 to entry: Definitions which command should be sync one or not are dependent on an application. They can be provided as a registered set of commands and responses or device profiles (see IEC 61158-6-27, 4.4 and Annex A).

**3.2.42**
**synchronous communication**
state or a way of communication for the FDC service of the Type 27 FAL, in which a command is issued at the synchronized timing with every communication cycle

Note 1 to entry: In this state, both sync commands and async ones can be issued.

Note 2 to entry: In this state, an out-of-synchronization error of APs shall be detected by measures of the watchdog counter.

**3.2.43**
**transmission cycle**
period of repetitive activities for the lower layers of the Type 27 fieldbus, which of all the slave devices are synchronized with that of a C1 master device by the lower layer protocol

**3.2.44**
**transmission mode**
state or a way of transmission for the lower layer protocol of the Type 27 fieldbus; cyclic mode, event driven mode

**3.2.45**
**virtual memory space**
large data block of APOs for the Type 27 FAL which can be read and write with pseudo-memory-addresses to provide consistency between different device models

Note 1 to entry: The virtual memory space includes the device information and other vender specific area. See IEC 61158-6-27, Annex B.

**3.2.46**
**warning**
field device status to tell that the device has detected a slight or passing problem but still working normally through the field device control (FDC) service of the Type 27 fieldbus

Note 1 to entry: Any warning statuses are latched and need to be operated to clear them.

Note 2 to entry: Warnings are classified into three groups, communication warnings, illegal-command-related ones, and application specific ones. But concrete definitions are dependent on implementation of each field devices.

### 3.3 Abbreviations and symbols

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

| | |
|---|---|
| AE | Application Entity |
| AL | Application Layer |
| A-, AL- | Application layer (as a prefix) |
| AP | Application Process |
| APDU | Application Protocol Data Unit |
| API | Application Process Invocation |
| APO | Application Process Object |
| APC | Application Process Context (as prefix of a protocol for Type 27 fieldbus) |
| APC SM | Application Process Context State Machine (for Type 27 fieldbus) |
| AR | Application Relationship |
| AR ASE | Application Relationship Application Service Element |
| AREP | Application Relationship End Point |
| ARPM | Application Relationship Protocol Machine (for Type 27 fieldbus) |
| ARPM-FDCM | ARPM for Field Device Control service Master (for Type 27 fieldbus) |
| ARPM-FDCMN | ARPM for Field Device Control service Monitor (for Type 27 fieldbus) |
| ARPM-FDCS | ARPM for Filed Device Control service Slave (for Type 27 fieldbus) |
| ARPM-MSG | ARPM for Message service (for Type 27 fieldbus) |
| ASCII | American Standard code for Information Interchange |
| ASDU | Application Service Data Unit |
| ASE | Application Service Element |
| ASN.1 | Abstract Syntax Notation One |
| Cnf | Confirm primitive |
| CTC | Communication Transmission Control |
| DL | Data-link-layer |
| DL- | (as a prefix) Data Link- |
| DLL | Data Link Layer |
| DLM | Data Link-management |
| DLMS | DL-management service |
| DLPDU | Data Link-Protocol Data Unit |
| DLSAP | Data Link Service Access Point |
| DLSDU | DL-service-data-unit |
| DMPM | Data Link layer Mapping Protocol Machine |
| FAL | Fieldbus Application Layer |
| FCS | Frame check sequence |
| FDC- | Field Device Control (as prefix of a service or a protocol for Type 27 fieldbus) |
| FDC ASE | Field Device Control Application Service Element (for Type 27 fieldbus) |
| FDCPM | Field Device Control Protocol Machine (for Type 27 fieldbus) |
| FDCPM-M | Field Device Control Protocol Machine for Master (for Type 27 fieldbus) |

| | |
|---|---|
| FDCPM-MN | Field Device Control Protocol Machine for Monitor (for Type 27 fieldbus) |
| FDCPM-S | Field Device Control Protocol Machine for Slave (for Type 27 fieldbus) |
| FIFO | First In First Out |
| FSPM | FAL service protocol machine |
| FSM- | Fieldbus System Management (as prefix of a service for Type 27 fieldbus) |
| FSM ASE | Fieldbus System Management Application Service Element for Type 27 fieldbus |
| FSMS | Fieldbus System management service |
| FSMUL | Field System Management Underlying Layer |
| HMI | Human-machine Interface |
| I/O | Input/output |
| ID | Identifier |
| IDL | Interface Definition Language |
| Ind | Indication primitive |
| LME | Layer Management Entity |
| Lsb | Least Significant Bit |
| Msb | Most Significant Bit |
| MSG | Message (as prefix of a service or a protocol for Type 27 fieldbus) |
| MSG ASE | Message Application Service Element for Type 27 fieldbus |
| MSGPM | Message Protocol Machine for Type 27 fieldbus |
| MSGPM-RQ | MSGPM for Requester for Type 27 fieldbus |
| MSGPM-RS | MSGPM for Responder for Type 27 fieldbus |
| OSI | Open Systems Interconnect |
| PM | Protocol machine |
| PDU | Protocol Data Unit |
| PhL | Ph-layer |
| QoS | Quality of Service |
| RAM | Random access memory |
| Req | Request primitive |
| Rsp | Response primitive |
| RSP | Response PDU for FDC service (for Type 27 fieldbus) |
| SAP | Service Access Point |
| SDN | Send Data with no Acknowledge |
| SDU | Service Data Unit |
| SM | Sync Master |
| SMIB | System Management Information Base |
| UML | Unified Modelling Language |

## 3.4 Conventions

### 3.4.1 Overview

The FAL is defined as a set of object-oriented ASEs. Each ASE is specified in a separate subclause. Each ASE specification is composed of two parts, its class specification, and its service specification.

The class specification defines the attributes of the class. It is assumed that the attributes are accessible from instances of the class using the Object Management ASE services specified in IEC 61158-1, 9.3. The service specification defines the services provided by the ASE.

The service model and service primitives are entirely abstract descriptions; therefore they do not represent specifications for implementation.

### 3.4.2 Conventions for class definitions

Class definitions are described using templates. Each template consists of a list of attributes for the class. The general form of the template is shown below:

| | | | |
|---|---|---|---|
| **FAL ASE:** | | | ASE Name |
| **CLASS:** | | | Class name |
| **CLASS ID:** | | | # |
| **PARENT CLASS:** | | | Parent class name |
| **ATTRIBUTES:** | | | |
| 1 | (o) | Key Attribute: | numeric identifier |
| 2 | (o) | Key Attribute: | Name |
| 3 | (m) | Attribute: | attribute name (values) |
| 4 | (m) | Attribute: | attribute name (values) |
| 4.1 | (s) | Attribute: | attribute name (values) |
| 4.2 | (s) | Attribute: | attribute name (values) |
| 4.3 | (s) | Attribute: | attribute name (values) |
| 5. | (c) | Constraint: | constraint expression |
| 5.1 | (m) | Attribute: | attribute name (values) |
| 5.2 | (o) | Attribute: | attribute name (values) |
| 6 | (m) | Attribute: | attribute name (values) |
| 6.1 | (s) | Attribute: | attribute name (values) |
| 6.2 | (s) | Attribute: | attribute name (values) |
| **SERVICES:** | | | |
| 1 | (o) | OpsService: | service name |
| 2 | (c) | Constraint: | constraint expression |
| 2.1 | (o) | OpsService: | service name |
| 3 | (m) | MgtService: | service name |

- The "FAL ASE:" entry is the name of the FAL ASE that provides the services for the class being specified.
- The "CLASS:" entry is the name of the class being specified. All objects defined using this template will be an instance of this class. The class may be specified by this document, or by a user of this document.
- The "CLASS ID:" entry is a number that identifies the class being specified. This number is unique within the FAL ASE that will provide the services for this class. When qualified by the identity of its FAL ASE, it unambiguously identifies the class within the scope of the FAL. The value "NULL" indicates that the class cannot be instantiated.
- The "PARENT CLASS:" entry is the name of the parent class for the class being specified. All attributes defined for the parent class and inherited by it are inherited for the class being defined, and therefore do not have to be redefined in the template for this class.

NOTE The parent-class "TOP" indicates that the class being defined is an initial class definition. The parent class TOP is used as a starting point from which all other classes are defined. The use of TOP is reserved for classes defined by this document.

- The "ATTRIBUTES" label indicates that the following entries are attributes defined for the class.
  - Each of the attribute entries contains a line number in column 1, a mandatory (m) / optional (o) / conditional (c) / selector (s) indicator in column 2, an attribute type label in column 3, a name or a conditional expression in column 4, and optionally a list of enumerated values in column 5. In the column following the list of values, the default value for the attribute may be specified.
  - Objects are normally identified by a numeric identifier or by an object name, or by both. In the class templates, these key attributes are defined under the key attribute.

  - The line number defines the sequence and the level of nesting of the line. Each nesting level is identified by period. Nesting is used to specify
    - fields of a structured attribute (4.1, 4.2, 4.3),
    - attributes conditional on a constraint statement (5). Attributes may be mandatory (5.1) or optional (5.2) if the constraint is true. Not all optional attributes require constraint statements as does the attribute defined in (5.2), and
    - the selection fields of a choice type attribute (6.1 and 6.2).
- The "SERVICES" label indicates that the following entries are services defined for the class.
  - An (m) in column 2 indicates that the service is mandatory for the class, while an (o) indicates that it is optional. A (c) in this column indicates that the service is conditional. When all services defined for a class are defined as optional, at least one has to be selected when an instance of the class is defined.
  - The label "OpsService" designates an operational service (1).
  - The label "MgtService" designates a management service (2).
  - The line number defines the sequence and the level of nesting of the line. Each nesting level is identified by period. Nesting within the list of services is used to specify services conditional on a constraint statement.

### 3.4.3 Conventions for service definitions

#### 3.4.3.1 General

This document uses the descriptive conventions given in ISO/IEC 10731 about services and their primitives.

<name of service primitive>::= <service name>-<service-primitive-name>.<primitive-type>,

where

<primitive-type>::= request | indication | response | confirm;

<service-name> identifies ASEs providing this type of FAL services;

::= FSM | EVM | FDC | MSG | AR.

#### 3.4.3.2 Service parameters

Service primitives are used to represent service user/service provider interactions (ISO/IEC 10731). They convey parameters which indicate information available in the user/provider interaction. In any particular interface, not all parameters need be explicitly stated.

The service specifications of this document use a tabular format to describe the component parameters of the ASE service primitives. The parameters which apply to each group of service primitives are set out in tables. Each table consists of up to five columns for

- the parameter name,
- request primitive,
- indication primitive,
- response primitive, and
- confirm primitive.

One parameter (or component of it) is listed in each row of each table. Under the appropriate service primitive columns, a code is used to specify the type of usage of the parameter on the primitive specified in the column:

M The parameter is mandatory

C The parameter is conditional

U The parameter is a user option, and can be provided or not depending on dynamic usage of the service user. When not provided, a default value for the parameter is assumed.

S The parameter is a selected item.

(blank) The parameter is never present.

Some entries are further qualified by items in brackets. These may be

– a parameter-specific constraint:

"(=)" indicates that the parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table, and

– an indication that some note applies to the entry:

"(n)" indicates that the following note "n" contains additional information pertaining to the parameter and its use.

#### 3.4.3.3 Service procedures

The procedures are defined in terms of

- the interactions between application entities through the exchange of fieldbus Application Protocol Data Units, and
- the interactions between an application layer service provider and an application layer service user in the same system through the invocation of application layer service primitives.

These procedures are applicable to instances of communication between systems that support time-constrained communications services within the FAL.

## 4 Concepts

### 4.1 Common concepts

The common concepts and templates used to describe the application layer service in this document are detailed in IEC 61158-1, Clause 9.

### 4.2 Type specific concepts

#### 4.2.1 General

This document and its companion Type 27 documents described a real-time Ethernet technology that aims to maximize the utilization of the full duplex Ethernet bandwidth.

#### 4.2.2 Node type

There are two node types; the master type and the slave type.

1) C1 master

One node shall exist as the master within the control domain in any case. The master executes the communication initialization before starting the sync communication. Handling of the communication initialization is executed by the application layer. After that, it executes cyclic transmissions and message transmissions with the slave in the control domain. Also, it controls the timing to switch transfer methods in the control domain that it manages.

2) Slave

Multiple nodes exist as the slave within the network. The slave can belong to multiple control domains, and it controls the timing to switch transfer methods and the timing to send from its own node in the control domain that it belongs to. The timing to send and the timing to switch