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Edition 1.0 2023-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Industrial communication networks – Fieldbus specifications – Part 6-27: Application layer protocol specification – Type 27 elements

Réseaux de communication industriels – Spécifications des bus de terrain – Partie 6-27: Spécification du protocole de la couche application – Éléments de type 27



IEC 61158-6-27:2023-03(en-fr)



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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-27: Application layer protocol specification – Type 27 elements

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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.

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- 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- withdrawn,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 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 documents positioned within the OSI or fieldbus reference models, otherwise incompatible systems can work together in any combination.

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-27: Application layer protocol specification – 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 behavior provided by the Type 27 fieldbus application layer in terms of

- the abstract syntax defining the application layer protocol data units conveyed between communicating application entities,
- the transfer syntax defining the application layer protocol data units conveyed between communicating application entities,
- the application context state machines defining the application service behavior visibly between communicating application entities, and
- the application relationship state machines defining the communication behavior visibly between communicating application entities.

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

- define the representation-on-wire of the service primitives defined in IEC 61158-5-27, and
- define the externally visible behavior associated with their transfer.

This document specifies the protocol of the Type 27 fieldbus application layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498-1) and the OSI Application Layer Structure (ISO/IEC 9545).

1.2 Specifications

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 61158-5-27.

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 IEC 61158-6 series.

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.

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 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 61158-5-27:2023, *Industrial communication networks – Fieldbus specifications – Part 5-27: Application layer service definition – Type 27 elements*

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 – Part 1: The Basic Model*

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

ISO/IEC 9899, *Information technology – Programming languages – C*

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

ISO/IEC 19501:2005, *Information technology – Open Distributed Processing – Unified Modeling Language (UML) Version 1.4.2*

ISO/IEC/IEEE 60559:2020, *Information technology – Microprocessor Systems – Floating-Point arithmetic*

ISO/IEC/IEEE 8802-3, *Telecommunications and exchange between information technology systems − Requirements for local and metropolitan area networks − Part 3: Standard for Ethernet*

IEEE Std 802.1D, *IEEE Standards for local and metropolitan area networks – Media Access Control (MAC) Bridges*

IEEE Std 802.1Q, *IEEE Standards for local and metropolitan area networks – Bridges and Bridged Networks*

IEEE Std 802.1AB, *IEEE Standards for Local and Metropolitan Area Networks: Station and Media Access Control Connectivity Discovery*

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

IETF RFC 768, J. Postel, "*User Datagram Protocol*", August 1980, available at <https://www.rfc-editor.org/info/rfc768> [viewed 2022-09-16]

IETF RFC 791, J. Postel, "*Internet Protocol*", September 1981, available at <https://www.rfc-editor.org/info/rfc791> [viewed 2022-09-16]

IETF RFC 826, D. Plummer, "*An Ethernet Address Resolution Protocol: or Converting Network Protocol Addresses to 48.bit Ethernet Address for Transmission on Ethernet Hardware*", November 1982, available at <https://www.rfc-editor.org/info/rfc826> [viewed 2022-09-16]

IETF RFC 1112, S.E. Deering, "*Host Extensions for IP Multicasting*", August 1989, available at <https://www.rfc-editor.org/info/rfc1112> [viewed 2022-09-16]

IETF RFC 2460, S. Deering and R. Hinden, "*Internet Protocol, Version 6 (IPv6) Specification*", December 1998, available at <https://www.rfc-editor.org/info/rfc2460> [viewed 2022-09-16]

3 Terms, definitions, abbreviated terms, symbols 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 Terms and definitions from ISO/IEC 7498-1

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;
- peer-(N)-entities;
- presentation context;
- real system;
- transfer syntax.

3.1.2 Terms and definitions from ISO/IEC 9545

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 Terms and definitions from ISO/IEC 8824-1

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

- simple type;
- component;
- component type;
- integer type;
- bitstring type;
- octetstring type;
- null type;
- sequence type;
- sequence of type;
- choice type;
- IA5String type;
- encoding.

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.

3.1.5 Terms and definitions from ISO/IEC 19501

For the purposes of this document, the following terms as defined in ISO/IEC 19501 apply:

- event;
- state;
- state machine;
- substate;
- submachine;
- transition.

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 devices.

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: Refer 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, and so on. 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 two, C1 master AP and slave AP, by their application roles in the fieldbus network.

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

3.2.10
communication
process to exchange information in a formal manner between two or more devices, users, APs or entities

3.2.11
transfer
process to convey a PDU from a sender to a receiver

3.2.12
transmission
process to send out and propagate electrical signals or encoded data

3.2.13
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 the transmission cycle multiplied by a specified scaling factor.

3.2.14
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

3.2.15
cyclic
repetitive in a regular manner

3.2.16
cyclic communication
transmission mode in which request PDUs and response PDUs are exchanged repetitively in the scheduled time slots synchronized with a transmission cycle of the Type 27

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

3.2.17
cycle scale counter
counter to generate a communication cycle by means of scaling a primary cycle or a transmission cycle

3.2.18
device ID
part of "Device Information" to identify the device for a specific product type or model of the Type 27 fieldbus

3.2.19
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

3.2.20
device profile
collection of device-model-common information and functionality providing consistency between different device models among the same kind of device

3.2.21
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

3.2.22
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.

3.2.23
error
abnormal condition or malfunction for communication or any other activities

3.2.24
field device control
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

3.2.25
field device protocol
FDC 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

3.2.26
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

Note 1 to entry: One or more units exist within the network as the node to send output data (command data) to slaves and receive input data (response data) from slaves in the data link layer. Also, it executes message data sending to/receiving from slaves. It can execute both or either one of input/output data sending/receiving and message data sending/receiving.

Note 2 to entry: Input/output data sending/receiving and message data sending/receiving shall be executed at a constant cycle and in a constant band.

Note 3 to entry: Or, it is an application type that executes field device control in the application layer.

3.2.27
message service
MSG service
communication service that handles the variable length data and does not require a severe restriction on response time

3.2.28
network clock
synchronized and periodically running counter that each node in a same network has, which becomes an oscillation source of the transmission cycle

3.2.29
primary cycle
period of repetitive activities synchronized with the transmission cycle before the connection establishing for the FDC protocol in Type 27 FAL

3.2.30
protocol machine
state machine that realizes a protocol as the main function of the entity in each layer

3.2.31
requester
class or its instance object of MSG ASE that plays a role of a command requester or sender for the Type 27 FAL

3.2.32
responder
class or its instance object of MSG ASE that plays a role of a command responder or receiver for the Type 27 FAL

3.2.33
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

3.2.34
service
operation or process that an object performs upon request from another object

3.2.35
single transfer
normal transfer mode for the FDC protocol of the Type 27 FAL in which a sender sends a PDU once a transaction

3.2.36
slave AP
AP type that has slave facilities for the FDC service of the Type 27 FAL, or the device implementing that AP type

3.2.37
slave
class or its instance object of FDC ASE that plays a role of a responder for the Type 27 FAL

Note 1 to entry: A node to receive output data (command data) from a master and send input data (response data) to the master that sent the output data in the data link layer. Also, it executes message data sending to/receiving from the master. It can execute input/output data and message data sending to/receiving from multiple masters. Also, it can receive input data of other slaves.

3.2.38
sync command
type of command 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: The definitions, which command is 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 Annex A.

3.2.39
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.

3.2.40
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

Note 1 to entry: Cycle in which the sync master sends a sync packet. The master having the band master function informs each node in the network. The sync band, the control domain transmission band, the IP transmission band and the guard band need to be within the transmission cycle. The transmission cycle starting point is managed by the sync master and is informed by the sync packet to all nodes. Between the master and slave within the control domain, or in the data link layer between the master having the band master function and the master without it, cyclic transmissions can be repeated at a cycle of n-times (n is an integer equal to or greater than zero) of the transmission cycle and it can vary from slave to slave.

3.2.41
transmission mode
state or a way of transmission for the lower layer protocol of the Type 27 fieldbus; cyclic mode, event driven mode

3.2.42
virtual memory space
large data block of APOs for the Type 27 FAL that can be read and written 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 Annex B.

3.2.43
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 an implementation of each field devices.

3.2.44
node
device that comply with the protocols described in this specification

3.2.45
node type
master or slave

3.2.46
multi control domain system
configuration where multiple control domains exist in the network

3.2.47
connected node
collective designation of master and slaves that are connected to the same network

3.2.48
primary node
initiator
node to start cyclic transmissions and message transmissions

Note 1 to entry: Only the master serves as the primary node.

3.2.49
secondary node
responder
node to execute cyclic transmissions and message transmissions according to the command from the primary node

3.2.50
output data
command data
data to be sent from a master to a slave

3.2.51
input data
response data
data to be sent from a slave to a master

3.2.52
input/output data
input data and output data

3.2.53
control data
collective designation of output data and input data

3.2.54
message data
data transmitted separately from the control data, which are exchanged between a master and a slave and sent when requested by the application

3.2.55
cyclic transmission
cyclic exchanging of control data between a master and a slave

3.2.56
message transmission
exchanging of message data to transmit information separately from the control data, which is, unlike cyclic transmission, conducted only when required by the application

3.2.57
IP transmission
communication using IP packets

3.2.58
control domain
logical group which consists of a master and slaves to exchange control data and/or message data

Note 1 to entry: Multiple control domains can exist in the network, and in this case, they are indicated as control domain #n (n is an integer).

Note 2 to entry: A slave shall belong to one or more control domains.

3.2.59
sync band
band to transmit sync packet

3.2.60
cyclic transmission band
band to execute cyclic transmissions

3.2.61
output data transmission band
band to transmit output data in cyclic transmissions

3.2.62
input data transmission band
band to transmit input data in cyclic transmissions

3.2.63
message transmission band
band to execute message transmissions

3.2.64
control domain transmission band
total band of the cyclic transmission band and the message transmission band within a control domain

3.2.65
IP transmission band
band to execute IP packet transmissions

3.2.66
guard band
band to prohibit sending/receiving by the devices in the network

3.2.67
destination address
address to specify the control data destination, having 16-bit information

3.2.68
source address
address to specify the control data source, having 16-bit information

3.2.69
node address
address to be specified as destination address or source address

3.2.70
logical node number
number from 1 to 127 to be used as serial number in ascending order, which enables the master to specify the slave, because there are 127 connectable slaves to the node address having 16-bit space in the data link layer

3.2.71
transmission delay time
time required for the frame sent by the sync master or the master in the data link layer to reach each node

Note 1 to entry: A total time of the signal propagation time in the transmission cables and the repeat time at the relay nodes.

3.2.72
response monitoring time
time to monitor the reception of responses

Note 1 to entry: This is measured from the starting of sending of data sent from the primary node (including the transmission time of the data sent from the primary node).

3.2.73
consecutive transmissions
continuous transmissions of output data

3.2.74
retransmission request
executing of input data retransmission request

3.2.75
event driven communication
communication mode where the master and the slave exchange data at an arbitrary timing, without executing clock synchronization in the devices by the sync packet sent from the sync master

3.2.76
transmission delay measurement
individual measurements by the sync master of transmission delay time for the nodes other than its own node

3.2.77
upstream
direction of data forwarding from the primary node to the secondary node

3.2.78
downstream
direction of data forwarding from the secondary node to the primary node

3.2.79
upstream port
port that becomes upstream among the communication ports to be implemented

Note 1 to entry: While multiple control domains exist in the network (two or more masters exist), in cases where the upstream port differs from control domain to control domain, it is referred to as the control domain #n (n is an integer) upstream port.

3.2.80
downstream port
port that becomes downstream among the communication ports to be implemented

Note 1 to entry: While multiple control domains exist in the network (two or mode masters exist), in cases where the downstream port differs from control domain to control domain, it is referred to as the control domain #n (n is an integer) downstream port.

3.2.81
transfer method to upstream
upstream transfer method among the transfer methods in the node where two or more communication ports are implemented

3.2.82
transfer method to downstream
downstream transfer method among the transfer methods in the node where two or more communication ports are implemented

3.2.83
store and forward
transfer method to store the received packets in the node first and forward them to the ports other than the receiving ports according to the result of stored data analysis and the band conditions upon receiving in the band

3.2.84
cut-through
transfer method to forward the received packets immediately to the ports other than the receiving port

3.2.85
repeat
transfer method to transfer the received packets in the same way as cut-through in cases where sending is not in progress in its own node, or to retain the received packets during sending from its own node and forward to the ports other than the receiving port after finishing sending from its own node

3.2.86
IP packet
all packets other than those with the MAC frame length/type field of RT-PDU ('F68E'H) in this document

3.2.87
sync packet
packet to synchronize transmission cycles of all the devices in the network, which is sent from the sync master

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)
ALME	Application Layer Management Entity
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-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
BM	Band Master
CDO	Communication Data Object
CMD	Command PDU for FDC service (for Type 27 fieldbus)

Cnf	confirm primitive
CTC	Communication Transfer Control Underlying Layer
DA	Destination Node Address
DLPDU	Data Link-Protocol Data Unit
DLSDU	Data Link Service Data Unit
DMPM	Data Link Mapping Protocol Machine
DMA	Destination MAC Address
E2PROM	Electrically erasable programmable read only memory
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-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
FSMUL	Field System Management Underlying Layer
HMI	Human-machine Interface
HS	Hand Shake
I/O	Input/output
ID	Identifier
Ind	indication primitive
LME	Layer Management Entity
Lsb	least significant bit
LT	Length or Type
MAC	Media Access Control
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 Interconnection
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)
SA	Source Node Address
SAP	Service Access Point
SDN	Send Data with no Acknowledge
SDU	Service Data Unit
SFD	Start Frame Delimiter
SM	Sync Master
SMA	Source MAC Address
SMIB	System Management Information Base
SRC	Send Receive Control Underlying Layer
UML	Unified Modelling Language

3.4 Conventions

3.4.1 General conventions

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 three parts: its class definitions, its services, and its protocol specification. The first two are contained in IEC 61158-5-27. The protocol specification for each of the ASEs is defined in this document.

The class definitions define the attributes of the classes supported by each ASE. In this document, it is assumed that every attribute are accessible only from the owner's instance object itself directly or through services of the class.

This document uses the descriptive conventions given in ISO/IEC 10731.

3.4.2 PDU data type conventions

The data types of FAL PDUs are defined with the notations of ASN.1.

Character strings that begin with "_" (low line) are used as data type symbols of FAL PDUs or their fields. A same string as a PDU type without "_" means a PDU instance of the corresponding data type.

Example CMD-PDU means an instance of _CMD-PDU and a following statement is omitted.

```
CMD-PDU  _CMD-PDU::= { value }
```

3.4.3 State machine conventions

The protocol sequences are described by means of State Machines.

In state chart diagrams, states are represented as boxes, and state transitions are shown as arrows. Their conventions are given in ISO/IEC 19501 as Universal Modeling Language (UML).

Names of states and transitions of the state diagram correspond to the names in the textual listing of the state transitions.

The textual listing of the state transitions is structured as Table 1.

The first row contains the name of the transition by an index number.

The second row defines the source state or the current state before the transition.

The third row contains an event and actions. The event is followed by optional arguments in parentheses, "(" and ")", and guard conditions in brackets, "[" and "]", as the first line. And the actions with starting character "/" follow the event line.

The last row contains the target state or the next state after the transition.

If the event occurs and the conditions are fulfilled the transition fires, i.e. the actions are executed and the next state is entered.

Table 1 – State transition descriptions

T#	Source State	Event (arguments) [conditions] / Action	Target state

A meaning of each element in Table 1 is shown in Table 2, based on UML "transition" definition (ISO/IEC 19501).

Table 2 – Description of state machine elements

Description element	Meaning
Source state Target state	Names of the originating state and the target state of transition.
T#	Name or number of the transition.
Event	Name or description of the trigger event that fire the transition.
(arguments)	A parameter value, an expression, or a sequence of those divided by "," for the event. The preceding "(" and the succeeding ")" are not part of the argument list.
[conditions]	Boolean expression, which is true for the transition to be fired. The preceding "[" and the succeeding "]" are not part of the condition.
/ Action	List of assignments and service or function invocations. The action should be atomic. The preceding "/" is not part of the action.
NOTE "(arguments)" and "[condition]" can be omitted if not necessary.	

The conventions used in the state machines are shown in Table 3.

Table 3 – Conventions used in state machines

Convention	Meaning
/*-- description --*/	Describes and explains conditions and/or procedure by using normal sentence between "/*--" and "--*/" instead of using the pseudo code notation. Example: /*-- The PM examines an occurrence of any alarms for the corresponding remote device. -- If an alarm is detected, the PM notifies it to the FSM ASE. -- If not, the PM transfers the MSGService-PDU to the DLL. --*/
=	Value of an item on the left is replaced by value of an item on the right. If an item on the right is a parameter, it comes from the primitive shown as an input event
Axx	Parameter name if 'a' is a letter Example: Identifier = reason; means value of a 'reason' parameter is assigned to a parameter called 'Identifier'
"xxx"	Fixed visible string Example: Identifier = "abc"; means value "abc" is assigned to a parameter named 'Identifier'
Nnn	If all elements are digits, the item represents a numerical constant shown in decimal representation.
0xnn	If all elements nn are digits, the item represents a numerical constant shown in hexadecimal representation.
==	Logical condition to indicate an item on the left is equal to an item on the right
<	Logical condition to indicate an item on the left is less than the item on the right
>	Logical condition to indicate an item on the left is greater than the item on the right
!=	Logical condition to indicate an item on the left is not equal to an item on the right
&&	Logical "AND"
||	Logical "OR"
!	Logical "NOT"
+ - * /	Arithmetic operators
;	Separator of expressions

Further notations as defined in C language (ISO/IEC 9899) can be used to describe conditions and actions.

4 Abstract syntax

4.1 General

Packet formats and frame formats comply with the ISO/IEC/IEEE 8802-3.