



IEC 61158-6-3

Edition 1.0 2007-12

INTERNATIONAL STANDARD

**Industrial communication networks – Fieldbus specifications –
Part 6-3: Application layer protocol specification – Type 3 elements**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE **XN**

ICS 35.100.70; 25.040.40

ISBN 2-8318-9475-1

CONTENTS

FOREWORD.....	8
INTRODUCTION.....	10
1 Scope.....	11
1.1 General.....	11
1.2 Specifications.....	12
1.3 Conformance.....	12
2 Normative references.....	12
3 Terms, definitions, abbreviations, symbols and conventions.....	13
3.1 Referenced terms and definitions.....	13
3.2 Additional definitions.....	14
3.3 Abbreviations and symbols.....	17
3.4 Conventions.....	19
3.5 Conventions used in state machines.....	21
4 FAL syntax description.....	24
4.1 APDU abstract syntax.....	24
4.2 Data types.....	28
5 Transfer syntax.....	30
5.1 Coding of basic data types.....	30
5.2 Coding section related to data exchange PDUs.....	33
5.3 Coding section related to slave diagnosis PDUs.....	33
5.4 Coding section related to parameterisation PDUs.....	44
5.5 Coding section related to configuration PDUs.....	50
5.6 Coding section related to global control PDUs.....	54
5.7 Coding section related to clock-value PDUs.....	55
5.8 Coding section related to function identification and errors.....	56
5.9 Coding section related to master diagnosis PDU.....	60
5.10 Coding section related to upload/download/act para PDUs.....	62
5.11 Coding section related to the bus parameter set.....	64
5.12 Coding section related to the slave parameter set.....	66
5.13 Coding section related to statistic counters.....	70
5.14 Coding section related to set slave address PDU.....	70
5.15 Coding section related to initiate/abort PDUs.....	70
5.16 Coding section related to read/write/data transport PDUs.....	74
5.17 Coding section related to load region and function invocation PDUs.....	74
5.18 Examples of diagnosis-RES-PDUs.....	77
5.19 Example of Chk_Cfg-REQ-PDU.....	79
5.20 Examples of Chk_Cfg-REQ-PDUs with DPV1 data types.....	80
5.21 Example structure of the Data_Unit for Data_Exchange.....	81
6 FAL protocol state machines.....	83
6.1 Overall structure.....	83
6.2 Assignment of state machines to devices.....	84
6.3 Overview DP-slave.....	85
6.4 Overview DP-master (class 1).....	87
6.5 Overview DP-master (class 2).....	88
6.6 Cyclic communication between DP-master (class 1) and DP-slave.....	89
6.7 Acyclic communication between DP-master (class 2) and DP-master (class 1).....	90
6.8 Acyclic communication between DP-master (class 1) and DP-slave.....	92

6.9	Application relationship monitoring.....	94
7	AP-context state machine	99
8	FAL service protocol machines (FSPMs).....	99
8.1	FSPMS.....	99
8.2	FSPMM1	134
8.3	FSPMM2	170
9	Application relationship protocol machines (ARPMs)	189
9.1	MSCY1S.....	189
9.2	MSAC1S.....	221
9.3	SSCY1S	234
9.4	MSRM2S	233
9.5	MSAC2S.....	243
9.6	MSCS1S.....	260
9.7	MSCY1M.....	262
9.8	MSAL1M.....	282
9.9	MSAC1M.....	291
9.10	MMAC1	304
9.11	MSCS1M	311
9.12	MSAC2M	316
9.13	MMAC2	332
10	DLL mapping protocol machines (DMPMs).....	339
10.1	DMPMS	339
10.2	DMPMM1	353
10.3	DMPMM2	370
11	Parameters for a DP-slave.....	379
	Bibliography.....	380
	Figure 1 – Common structure of specific fields	20
	Figure 2 – Coding of the data type BinaryDate.....	31
	Figure 3 – Encoding of TimeOfDay value.....	31
	Figure 4 – Encoding of Time Difference value.....	32
	Figure 5 – Encoding of Network Time value.....	32
	Figure 6 – Encoding of Network Time Difference value	33
	Figure 7 – Example Modul_Status_Array	38
	Figure 8 – Example of Ext_Diag_Data in case of DPV1 diagnosis format with alarm and status PDU.....	78
	Figure 9 – Example of Ext_Diag_Data in case of the basic diagnosis format	79
	Figure 10 – Example of a special identifier format.....	79
	Figure 11 – Example of a special identifier format with data types.....	80
	Figure 12 – Example of a special identifier format with data types.....	80
	Figure 13 – Example of a empty slot with data types.....	81
	Figure 14 – Example for multi-variable device with AI and DO function blocks.....	81
	Figure 15 – Identifiers (ID)	82
	Figure 16 – Identifier list.....	82
	Figure 17 – Structure of the Data_Unit for the request- and response-DLPDU.....	82
	Figure 18 – Structuring of the protocol machines and adjacent layers in a DP-slave.....	86

Figure 19 – Structuring of the protocol machines and adjacent layers in a DP-master (class 1).....	87
Figure 20 – Structuring of the protocol machines and adjacent layers in a DP-master (class 2).....	88
Figure 21 – Sequence of the communication between DP-master and DP-slave.....	90
Figure 22 – Sequence of communication between DP-master (class 2) and DP-master (class 1).....	92
Figure 23 – Sequence of acyclic communication between DP-master (class 1) and DP-slave.....	94
Figure 24 – Example for connection establishment on MS2.....	96
Figure 25 – Idle at master-side on MS2.....	97
Figure 26 – Idle at slave-side on MS2.....	98
Figure 27 – Example for connection establishment on MS2(server-side).....	239
Figure 28 – Structure of RM entries in the RM_Registry.....	240
Table 1 – State machine description elements.....	21
Table 2 – Description of state machine elements.....	21
Table 3 – Conventions used in state machines.....	22
Table 4 – APDU syntax.....	24
Table 5 – Substitutions.....	27
Table 6 – Alarm_Type range.....	36
Table 7 – Status_Type value range.....	36
Table 8 – Alarm_Specifier.....	37
Table 9 – Range of Modul_Status_Entry (1-4).....	39
Table 10 – Error type.....	41
Table 11 – Specification of the bits Lock_Req and Unlock_Req.....	44
Table 12 – Range of Length_of_Manufacturer_Specific_Data if used in Chk_Cfg-REQ-PDU.....	51
Table 13 – Range of Length_of_Manufacturer_Specific_Data if used in Get_Cfg-RES-PDU.....	51
Table 14 – Values (codes) for data types.....	53
Table 15 – Specification of the bits for Un-/Sync and Un-/Freeze.....	54
Table 16 – Coding of the Function_Code/ Function_Num.....	57
Table 17 – Coding of the Error_Code / Function_Num.....	58
Table 18 – Values of Error_Decode.....	58
Table 19 – Coding of Error_Code_1 at DPV1.....	59
Table 20 – Values of MDiag_Identifier.....	60
Table 21 – Values for Area_Code_UpDownload.....	62
Table 22 – Values for Area_CodeActBrct.....	63
Table 23 – Values for Area_CodeAct.....	63
Table 24 – Values for Data_rate.....	64
Table 25 – Values for Slave_Type.....	67
Table 26 – Values for Alarm_Mode.....	68
Table 27 – Values for Subnet.....	73
Table 28 – Values of reason code if instance is DLL.....	73

Table 29 – Values of reason code if instance is MS2	73
Table 30 – Values of Extended_Function_Num	74
Table 31 – Values of FI_State	76
Table 32 – Assignment of state machines	85
Table 33 – Primitives issued by AP-Context to FSPMS	99
Table 34 – Primitives issued by FSPMS to AP-Context	101
Table 35 – FSPMS state table	108
Table 36 – Functions used by the FSPMS	133
Table 37 – Primitives issued by AP-Context to FSPMM1	135
Table 38 – Primitives issued by FSPMM1 to AP-Context	137
Table 39 – FSPMM1 state table	144
Table 40 – Functions used by the FSPMM1	170
Table 41 – Primitives issued by AP-Context to FSPMM2	171
Table 42 – Primitives issued by FSPMM2 to AP-Context	173
Table 43 – FSPMM2 state table	176
Table 44 – Functions used by the FSPMM2	188
Table 45 – Primitives issued by FSPMS to MSCY1S	189
Table 46 – Primitives issued by MSCY1S to FSPMS	190
Table 47 – Rules for DPV1_Status_1, DPV1_Status_2 and DPV1_Status_3 check	192
Table 48 – MSCY1S state table	197
Table 49 – Functions used by the MSCY1S	219
Table 50 – Primitives issued by FSPMS to MSAC1S	221
Table 51 – Primitives issued by MSAC1S to FSPMS	222
Table 52 – Primitives issued by MSCY1S to MSAC1S	222
Table 53 – Primitives issued by MSAC1S to MSCY1S	222
Table 54 – Parameter used with primitives exchanged between MSAC1S and MSCY1S	222
Table 55 – MSAC1S state table	224
Table 56 – Functions used by the MSAC1S	234
Table 57 – Primitives issued by FSPMS to SSCY1S	234
Table 58 – Primitives issued by SSCY1S to FSPMS	235
Table 59 – SSCY1S state table	236
Table 60 – Functions used by the SSCY1S	237
Table 61 – Primitives issued by FSPMS to MSRM2S	238
Table 62 – Primitives issued by MSRM2S to FSPMS	238
Table 63 – MSRM2S state table	241
Table 64 – Primitives issued by FSPMS to MSAC2S	244
Table 65 – Primitives issued by MSAC2S to FSPMS	245
Table 66 – Primitives issued by MSRM2S to MSAC2S	245
Table 67 – Primitives issued by MSAC2S to MSRM2S	246
Table 68 – Parameter used with primitives exchanged with MSAC2S	246
Table 69 – MSAC2S state table	249
Table 70 – Primitives issued by MSCS1S to FSPMS	261
Table 71 – MSCS1S state table	262

Table 72 – Primitives issued by FSPMM1 to MSCY1M	263
Table 73 – Primitives issued by MSCY1M to FSPMM1	264
Table 74 – Parameters used with primitives exchanged between FSPMM1 and MSCY1M	264
Table 75 – MSCY1M state table	267
Table 76 – Primitives issued by FSPMM1 to MSAL1M.....	282
Table 77 – Primitives issued by MSAL1M to FSPMM1.....	283
Table 78 – Primitives issued by MSCY1M to MSAL1M	283
Table 79 – Primitives issued by MSAL1M to MSCY1M	283
Table 80 – Parameter used with primitives exchanged between MSAL1M and MSCY1M	283
Table 81 – Possible values in the Alarm_State_Table	284
Table 82 – MSAL1M state table.....	287
Table 83 – Primitives issued by FSPMM1 to MSAC1M	292
Table 84 – Primitives issued by MSAC1M to FSPMM1	292
Table 85 – Primitives issued by MSAL1M to MSAC1M	293
Table 86 – Primitives issued by MSAC1M to MSAL1M	293
Table 87 – Parameter used with primitives exchanged between MSAL1M and MSCY1M	293
Table 88 – MSAC1M state table	299
Table 89 – Primitives issued by FSPMM1 to MMAC1	305
Table 90 – Primitives issued by MMAC1 to FSPMM1	305
Table 91 – MMAC1 state table.....	307
Table 92 – Primitives issued by FSPMM1 to MSCS1M	312
Table 93 – Primitives issued by MSCS1M to FSPMM1	312
Table 94 – MSCS1M state table	314
Table 95 – Primitives issued by FSPMM2 to MSAC2M	316
Table 96 – Primitives issued by MSAC2M to FSPMM2	317
Table 97 – Parameters used with primitives exchanged with MSAC2M.....	317
Table 98 – MSAC2M state table	321
Table 99 – Primitives issued by FSPMM2 to MMAC2	332
Table 100 – Primitives issued by MMAC2 to FSPMM2	333
Table 101 – Parameters used with primitives exchanged with MMAC2	333
Table 102 – MMAC2 state table.....	334
Table 103 – Primitives issued by FSPMS to DMPMS	339
Table 104 – Primitives issued by DMPMS to FSPMS	340
Table 105 – Primitives issued by MSCY1S to DMPMS	340
Table 106 – Primitives issued by DMPMS to MSCY1S	341
Table 107 – Primitives issued by DMPMS to SSCY1S.....	341
Table 108 – Primitives issued by MSAC1S, MSRM2S, MSAC2S to DMPMS	342
Table 109 – Primitives issued by DMPMS to MSAC1S, MSRM2S, MSAC2S	342
Table 110 – Primitives issued by DMPMS to MSCS1S	342
Table 111 – Primitives issued by DMPMS to DL.....	343
Table 112 – Primitives issued by DL to DMPMS.....	344
Table 113 – Parameters used with primitives exchanged with DMPMS.....	345
Table 114 – DMPMS state table	346

Table 115 – Functions used by the DMPMS.....	352
Table 116 – Primitives issued by FSPMM1 to DMPMM1.....	353
Table 117 – Primitives issued by DMPMM1 to FSPMM1.....	354
Table 118 – Primitives issued by MSCY1M to DMPMM1	354
Table 119 – Primitives issued by DMPMM1 to MSCY1M	355
Table 120 – Primitives issued by MSAL1M, MSAC1M to DMPMM1	355
Table 121 – Primitives issued by DMPMM1 to MSAL1M, MSAC1M	355
Table 122 – Primitives issued by MMAC1 to DMPMM1	356
Table 123 – Primitives issued by DMPMM1 to MMAC1	356
Table 124 – Primitives issued by MSCS1M to DMPMM1	356
Table 125 – Primitives issued by DMPMM1 to MSCS1M	357
Table 126 – Primitives issued by DMPMM1 to DL	357
Table 127 – Primitives issued by DL to DMPMM1	358
Table 128 – Parameters used with primitives exchanged with DMPMM1	359
Table 129 – Possible values of status.....	360
Table 130 – DMPMM1 state table.....	361
Table 131 – Functions used by the DMPMM1	369
Table 132 – Primitives issued by FSPMM2 to DMPMM2.....	370
Table 133 – Primitives issued by DMPMM2 to FSPMM2	371
Table 134 – Primitives issued by MSAC2M to DMPMM2	371
Table 135 – Primitives issued by DMPMM2 to MSAC2M	371
Table 136 – Primitives issued by MMAC2 to DMPMM2	372
Table 137 – Primitives issued by DMPMM2 to MMAC2	372
Table 138 – Primitives issued by DMPMM2 to DL	373
Table 139 – Primitives issued by DL to DMPMM2	373
Table 140 – Parameters used with primitives exchanged with DMPMM2	374
Table 141 – DMPMM2 state table	374
Table 142 – Functions used by DMPMM2	378
Table 143 – Bus parameter/reaction times for a DP-slave.....	379

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
 FIELDBUS SPECIFICATIONS –**
Part 6-3: Application layer protocol specification – Type 3 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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 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.

NOTE Use of some of the associated protocol types is restricted by their 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 particular data-link layer protocol type to be used with physical layer and application layer protocols in Type combinations as specified explicitly in the IEC 61784 series. Use of the various protocol types in other combinations may require permission from their respective intellectual-property-right holders.

IEC draws attention to the fact that it is claimed that compliance with this standard may involve the use of patents as follows, where the [xx] notation indicates the holder of the patent right:

The following patent rights for Type 3 have been announced:

DE 36 43 979 C2	[SI]	Deterministisches Zugriffsverfahren nach dem Tokenprinzip für eine Datenübertragung
DE 36 43 979 A1	[SI]	Deterministisches Zugriffsverfahren nach dem Tokenprinzip für eine Datenübertragung

IEC takes no position concerning the evidence, validity and scope of these patent rights.

The holders of these patent rights have assured IEC that they are willing to negotiate licenses under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holders of these patent rights are registered with IEC. Information may be obtained from:

[SI]: SIEMENS AG
 Ludwig Winkel
 Siemensallee 73
 D-76181 Karlsruhe
 Germany

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61158-6-3 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This first edition and its companion parts of the IEC 61158-6 subseries cancel and replace IEC 61158-6:2003. This edition of this part constitutes an editorial revision.

This edition of IEC 61158-6 includes the following significant changes from the previous edition:

- a) deletion of the former Type 6 fieldbus for lack of market relevance;
- b) addition of new types of fieldbuses;
- c) partition of part 6 of the third edition into multiple parts numbered -6-2, -6-3, ...

The text of this standard is based on the following documents:

FDIS	Report on voting
65C/476/FDIS	65C/487/RVD

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

This publication has been drafted in accordance with ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under <http://webstore.iec.ch> in the data related to the specific publication. At this date, the publication will be:

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

NOTE The revision of this standard will be synchronized with the other parts of the IEC 61158 series.

The list of all the parts of the IEC 61158 series, under the general title *Industrial communication networks – fieldbus specifications*, can be found on the IEC web site.

INTRODUCTION

This part of IEC 61158 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/TR 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 standard 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 implementors 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 standard is concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices. By using this standard together with other standards positioned within the OSI or fieldbus reference models, otherwise incompatible systems may work together in any combination.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-3: Application layer protocol specification – Type 3 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 standard provides common elements for basic time-critical and non-time-critical messaging communications between application programs in an automation environment and material specific to Type 3 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 standard defines in an abstract way the externally visible behavior provided by the Type 3 fieldbus application layer in terms of

- a) the abstract syntax defining the application layer protocol data units conveyed between communicating application entities,
- b) the transfer syntax defining the application layer protocol data units conveyed between communicating application entities,
- c) the application context state machine defining the application service behavior visible between communicating application entities; and
- d) the application relationship state machines defining the communication behavior visible between communicating application entities; and.

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

- 1) define the wire-representation of the service primitives specified in IEC 61158-5-3, and
- 2) define the externally visible behavior associated with their transfer.

This standard specifies the protocol of the Type 3 fieldbus application layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498) and the OSI Application Layer Structure (ISO/IEC 9545).

FAL services and protocols are provided by FAL application-entities (AE) contained within the application processes. The FAL AE is composed of a set of object-oriented Application Service Elements (ASEs) and a Layer Management Entity (LME) that manages the AE. The ASEs provide communication services that operate on a set of related application process object (APO) classes. One of the FAL ASEs is a management ASE that provides a common set of services for the management of the instances of FAL classes.

Although these services specify, from the perspective of applications, how request and responses are issued and delivered, they do not include a specification of what the requesting and responding applications are to do with them. That is, the behavioral aspects of the applications are not specified; only a definition of what requests and responses they can 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 standard to provide access to the FAL to control certain aspects of its operation.

1.2 Specifications

The principal objective of this standard is to specify the syntax and behavior of the application layer protocol that conveys the application layer services defined in IEC 61158-5-3.

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 parts of the IEC 61158-6 series.

1.3 Conformance

This standard does not specify individual implementations or products, nor does it constrain the implementations of application layer entities within industrial automation systems.

There is no conformance of equipment to the application layer service definition standard. Instead, conformance is achieved through implementation of this application layer protocol specification.

2 Normative references

The following referenced documents are indispensable for the application 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.

IEC 60559, *Binary floating-point arithmetic for microprocessor systems*

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

IEC 61158-4-3, *Industrial communication networks – Fieldbus specifications – Part 4-3: Data-link layer protocol specification – Type 3 elements*

IEC 61158-5-3, *Industrial communication networks – Fieldbus specifications – Part 5-3: Application layer service definition – Type 3 elements*

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

ISO/IEC 7498-1, *Information technology – Open Systems Interconnection – Basic Reference Model – Part1: The Basic Model*

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

ISO/IEC 8824, *Information technology – Open Systems Interconnection – Specification of Abstract Syntax Notation One (ASN.1)*

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