

# INTERNATIONAL STANDARD



**Industrial communication networks – Fieldbus specifications –  
Part 5-10: Application layer service definition – Type 10 elements**



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2010 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland  
Email: [inmail@iec.ch](mailto:inmail@iec.ch)  
Web: [www.iec.ch](http://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 corrigenda or an amendment might have been published.

- Catalogue of IEC publications: [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: [www.iec.ch/online\\_news/justpub](http://www.iec.ch/online_news/justpub)

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: [www.iec.ch/webstore/custserv](http://www.iec.ch/webstore/custserv)

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: [csc@iec.ch](mailto:csc@iec.ch)  
Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00

# INTERNATIONAL STANDARD



**Industrial communication networks – Fieldbus specifications –  
Part 5-10: Application layer service definition – Type 10 elements**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

PRICE CODE **XH**

ICS 25.04.40; 35.100.70; 35.110

ISBN 978-2-88912-107-6

## CONTENTS

FOREWORD.....	14
INTRODUCTION.....	16
1 Scope.....	17
1.1 Overview.....	17
1.2 Specifications.....	18
1.3 Conformance.....	18
2 Normative references.....	18
3 Terms, definitions, abbreviations, symbols and conventions.....	20
3.1 Referenced terms and definitions.....	20
3.2 Additional terms and definitions for distributed automation.....	21
3.3 Additional terms and definitions for decentralized periphery.....	23
3.4 Additional terms and definitions for media redundancy.....	31
3.5 Abbreviations and symbols.....	32
3.6 Additional abbreviations and symbols for distributed automation.....	33
3.7 Additional abbreviations and symbols for decentralized periphery.....	33
3.8 Additional abbreviations and symbols for media redundancy.....	34
3.9 Conventions.....	34
4 Concepts.....	37
5 Data type ASE.....	37
5.1 General.....	37
5.2 Formal definition of data type objects.....	40
5.3 FAL defined data types.....	41
5.4 Data type ASE service specification.....	84
6 Communication model for common services.....	84
6.1 Concepts.....	84
6.2 ASE data types.....	84
6.3 ASEs.....	85
7 Communication model for distributed automation.....	185
7.1 Concepts.....	185
7.2 ASE data types.....	191
7.3 ASEs.....	195
7.4 ARs.....	412
7.5 Summary of FAL classes.....	416
7.6 Summary of FAL services.....	417
8 Communication model for decentralized periphery.....	419
8.1 Concepts.....	419
8.2 ASE data types.....	436
8.3 ASEs.....	436
8.4 Behavior of an IO device.....	709
8.5 Behavior of an IO controller.....	753
8.6 Application characteristics.....	756
Annex A (informative) Device instances.....	759
Annex B (informative) Components of an Ethernet interface.....	761
Annex C (informative) Scheme of MAC address assignment.....	765
Annex D (informative) Collection of objects.....	766
Annex E (informative) Measurement of the fast startup time.....	767
Bibliography.....	768

Figure 1 – Data type class hierarchy example .....	38
Figure 2 – NetworkTime date relation .....	63
Figure 3 – PTCP applications.....	98
Figure 4 – Clock drift measurement .....	109
Figure 5 – Multiple synchronization.....	110
Figure 6 – MRP stack .....	112
Figure 7 – Ring topology with one manager and clients.....	123
Figure 8 – MRM in an open ring .....	123
Figure 9 – More than one MRM in the ring .....	124
Figure 10 – Media redundancy diagnosis dependencies .....	125
Figure 11 – Locating the destination for redundant RT frames .....	165
Figure 12 – Example of periods at a local port .....	172
Figure 13 – FAL ASEs communication architecture.....	187
Figure 14 – Runtime object model.....	188
Figure 15 – Relationship between engineering and runtime.....	189
Figure 16 – Navigation in the runtime object model.....	190
Figure 17 – Operating state block diagram.....	229
Figure 18 – Device status model for the common diagnosis .....	230
Figure 19 – ACCO ASE structure .....	261
Figure 20 – Productive operation of data connections .....	262
Figure 21 – Quality code transfer – standard behavior .....	274
Figure 22 – Startup of a connection .....	275
Figure 23 – Quality code with communication fault.....	275
Figure 24 – Quality code when a connection is cleared.....	276
Figure 25 – Quality code when a connection is deactivated .....	276
Figure 26 – Quality code during the transfer of "incorrect" connection data.....	277
Figure 27 – Quality code for provider in "CBARReady" state .....	278
Figure 28 – Quality code when clearing an object from the provider .....	278
Figure 29 – Quality code when a connection is forced.....	279
Figure 30 – Quality code at QoS violation .....	279
Figure 31 – Push mode.....	286
Figure 32 – Pull mode overview .....	287
Figure 33 – Detailed sequence chart of the pull mode.....	288
Figure 34 – QoS and ORPC communication channel .....	289
Figure 35 – QoS Violation within Pull Mode .....	290
Figure 36 – Monitoring the providers heartbeat .....	291
Figure 37 – State machine RemoteACCO .....	293
Figure 38 – State machine RemoteACCOProvider .....	293
Figure 39 – State machine RemoteACCOProvider <sub>ORPC</sub> .....	294
Figure 40 – State machine AR <sub>ORPC</sub> – Provider .....	294
Figure 41 – State machine GetConnectionData – Provider.....	295
Figure 42 – State machine ProviderConnection.....	295
Figure 43 – State machine ProvConnActivation.....	296
Figure 44 – State machine WorkerORPC .....	296
Figure 45 – Communication stack of distributed automation devices .....	297
Figure 46 – Application relations between devices .....	298
Figure 47 – Communication relations .....	298
Figure 48 – RT communication channel .....	300

Figure 49 – Interaction between provider and consumer .....	302
Figure 50 – State machine AR <sub>SRT</sub> – Consumer .....	304
Figure 51 – State machine AR <sub>SRT</sub> – Provider .....	305
Figure 52 – State machine AccoDataCR – Consumer .....	306
Figure 53 – State machine AccoDataCR – Provider .....	306
Figure 54 – RT frame layout .....	307
Figure 55 – Establishing an AccoDataCR .....	308
Figure 56 – Flowchart of the copy cycle for local connections .....	309
Figure 57 – State machine connect attempt .....	313
Figure 58 – Productive operation of data connections (ORPC channel) .....	320
Figure 59 – Productive operation of data connections (RT channel) .....	321
Figure 60 – Productive operation of data connections (Local channel) .....	321
Figure 61 – Data flow for cyclic RT .....	322
Figure 62 – Failure of the provider in productive operation (ORPC push mode) .....	324
Figure 63 – Failure of the provider in productive operation (ORPC pull mode) .....	325
Figure 64 – Scenario 1: Provider failure in productive operation (RT) .....	326
Figure 65 – Scenario 2: Recovery from provider failure in productive operation (RT) .....	327
Figure 66 – Failure of the consumer (push mode) .....	327
Figure 67 – Failure of the consumer (pull mode) .....	328
Figure 68 – Failure of the consumer .....	329
Figure 69 – Failure of the provider when setting up connections .....	331
Figure 70 – Information levels .....	332
Figure 71 – ACCO ASE status model for the common diagnosis .....	332
Figure 72 – ACCO ASE status model for the detailed diagnosis .....	333
Figure 73 – Structure of the transmitted connection data .....	375
Figure 74 – Example of communication between controlling devices and field devices .....	421
Figure 75 – Example of communication between an engineering station and several controlling and field devices .....	421
Figure 76 – Example of communication between field devices and a server station .....	422
Figure 77 – Example of communication between field devices .....	422
Figure 78 – Structural units of one arbitrary API of an IO device (general) .....	424
Figure 79 – Example 1 structural units for interfaces and ports within API 0 .....	425
Figure 80 – Example 2 structural units for interfaces and ports within API 0 .....	426
Figure 81 – Overview of application processes .....	428
Figure 82 – IO device with APs, slots and subslots .....	429
Figure 83 – Application Process with application process objects (APOs) .....	432
Figure 84 – Access to a remote APO .....	433
Figure 85 – Access to a remote APO for provider/consumer association .....	434
Figure 86 – Example of one AR with two AREPs .....	435
Figure 87 – Relation of a record data object to one real object .....	437
Figure 88 – Relation of a record data object to two real objects .....	438
Figure 89 – Overview IO ASE service interactions .....	448
Figure 90 – Example of a resource model at the alarm source .....	524
Figure 91 – General isochronous application model (example) .....	588
Figure 92 – ASE relations in an IO device operating in isochronous mode .....	594
Figure 93 – State machine relations in an IO device operating in isochronous mode .....	594
Figure 94 – SyncCtl state diagram .....	598
Figure 95 – Output state diagram .....	600
Figure 96 – Input state diagram .....	605

Figure 97 – Assignment of communication relationship to application relationship .....	687
Figure 98 – Implicit application relationship .....	691
Figure 99 – Example IO application relationship (one-to-one) .....	692
Figure 100 – Example IO application relationship one-to-many .....	693
Figure 101 – Overview ASE state machines for IO device .....	709
Figure 102 – State diagram application startup IO device .....	711
Figure 103 – State diagram neighborhood check .....	719
Figure 104 – State diagram PD parameter check IO device .....	728
Figure 105 – State diagram for a submodule.....	738
Figure 106 – State diagram IO controller during startup .....	754
Figure 107 – Example of network topology including slower wireless segments .....	757
Figure 108 – Example of media redundancy including wireless segments .....	758
Figure A.1 – Instance model .....	759
Figure B.1 – Scheme of an Ethernet interface .....	761
Figure B.2 – Scheme of an Ethernet interface with bridging ability .....	762
Figure B.3 – Scheme of an Ethernet interface with optical ports.....	763
Figure B.4 – Scheme of an Ethernet interface with bridging ability using radio communication.....	764
Figure B.5 – Scheme of an Ethernet interface with radio communication.....	764
Figure C.1 – Scheme of MAC address assignment.....	765
Figure D.1 – Example for an intersection of IO device, slot, and AR.....	766
Figure E.1 – Measurement of the fast startup time.....	767
Table 1 – V2 octets .....	42
Table 2 – L2 octets .....	42
Table 3 – PERSISTDEF .....	45
Table 4 – VARTYPE .....	45
Table 5 – ITEMQUALITYDEF .....	46
Table 6 – STATEDEF .....	49
Table 7 – GROUPEXCEPTIONDEF .....	49
Table 8 – ACCESSRIGHTSDEF .....	50
Table 9 – HRESULT .....	50
Table 10 – E2 octets .....	52
Table 11 – E2 value range .....	53
Table 12 – Unipolar2.16 octets .....	53
Table 13 – Unipolar2.16 value range .....	53
Table 14 – N2 value range .....	55
Table 15 – N4 value range .....	55
Table 16 – X2 value range .....	56
Table 17 – X4 value range .....	57
Table 18 – C4 value range .....	57
Table 19 – T2 value range .....	59
Table 20 – T2 value range .....	59
Table 21 – D2 value range .....	60
Table 22 – R2 value range .....	60
Table 23 – UUID for decentralized peripherals .....	61
Table 24 – UUID for distributed automation .....	62
Table 25 – NetworkTime values .....	63
Table 26 – NetworkTime octets .....	63



Table 27 – UNICODEString values .....	65
Table 28 – UTF-8 character encoding scheme .....	65
Table 29 – OctetString2+Unsigned8 octets .....	76
Table 30 – Float32+Unsigned8 octets .....	77
Table 31 – Unsigned8+Unsigned8 octets .....	77
Table 32 – Data Types for Value in a VARIANT .....	80
Table 33 – Unsigned16_S octets .....	81
Table 34 – Unsigned16_S meaning .....	81
Table 35 – Integer16_S octets .....	81
Table 36 – Integer16_S meaning .....	82
Table 37 – Unsigned8_S octets .....	82
Table 38 – Unsigned8_S meaning .....	82
Table 39 – OctetString_S octets .....	83
Table 40 – OctetString_S status bits .....	83
Table 41 – F message trailer with 4 octets .....	83
Table 42 – F message trailer with 5 octets .....	84
Table 43 – Get .....	90
Table 44 – Set .....	92
Table 45 – Identify .....	95
Table 46 – Hello .....	96
Table 47 – Start bridge .....	103
Table 48 – Start slave .....	104
Table 49 – Start master .....	105
Table 50 – Stop bridge .....	106
Table 51 – Stop slave .....	107
Table 52 – Stop master .....	107
Table 53 – Sync state change .....	108
Table 54 – Start MRM .....	117
Table 55 – Stop MRM .....	118
Table 56 – Redundancy state change .....	119
Table 57 – Start MRC .....	120
Table 58 – Stop MRC .....	121
Table 59 – Neighborhood changed .....	121
Table 60 – MRP network/connection parameters .....	126
Table 61 – MRM parameters .....	127
Table 62 – MRC parameters .....	127
Table 63 – Set Prov Data .....	128
Table 64 – Set Prov Status .....	129
Table 65 – PPM Activate .....	130
Table 66 – Close .....	131
Table 67 – Start .....	131
Table 68 – Error .....	132
Table 69 – Get Cons Data .....	132
Table 70 – Get cons status .....	133
Table 71 – Set RedRole .....	133
Table 72 – CPM activate .....	134
Table 73 – APMS Activate .....	138
Table 74 – APMR Activate .....	139
Table 75 – APMS A Data .....	140