

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Industrial communication networks – Fieldbus specifications –
Part 6-10: Application layer protocol specification – Type 10 elements**

**Réseaux de communication industriels – Spécifications des bus de terrain –
Partie 6-10: Spécification de protocole de couche d'application – Éléments
de type 10**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2019 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 Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

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 It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC online collection - oc.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 22 000 terminological entries in English and French, with equivalent terms in 18 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 online collection - oc.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 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Industrial communication networks – Fieldbus specifications –
Part 6-10: Application layer protocol specification – Type 10 elements**

**Réseaux de communication industriels – Spécifications des bus de terrain –
Partie 6-10: Spécification de protocole de couche d'application – Eléments
de type 10**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 25.040.40; 35.100.70; 35.110

ISBN 978-2-8322-9740-7

**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.**

CONTENTS

| | |
|--|-----|
| FOREWORD..... | 37 |
| INTRODUCTION..... | 39 |
| 1 Scope..... | 41 |
| 1.1 General..... | 41 |
| 1.2 Specifications | 41 |
| 1.3 Conformance | 41 |
| 2 Normative references | 42 |
| 3 Terms, definitions, abbreviated terms, symbols and conventions | 45 |
| 3.1 Referenced terms and definitions..... | 45 |
| 3.1.1 ISO/IEC 7498-1 terms..... | 45 |
| 3.1.2 ISO/IEC 8822 terms..... | 45 |
| 3.1.3 ISO/IEC 8824-1 terms..... | 45 |
| 3.1.4 ISO/IEC 9545 terms..... | 45 |
| 3.2 Terms and definitions for decentralized periphery | 46 |
| 3.3 Abbreviated terms and symbols | 54 |
| 3.3.1 Abbreviated terms and symbols for media redundancy | 54 |
| 3.3.2 Abbreviated terms and symbols for decentralized periphery..... | 54 |
| 3.3.3 Abbreviated terms and symbols for services..... | 58 |
| 3.3.4 Abbreviated terms and symbols for IEEE 802.1Q..... | 58 |
| 3.3.5 Abbreviated terms and symbols for IETF RFC 2474..... | 58 |
| 3.3.6 Abbreviated terms and symbols for IETF RFC 4291..... | 58 |
| 3.4 Conventions..... | 58 |
| 3.4.1 General concept | 58 |
| 3.4.2 Conventions for decentralized periphery | 58 |
| 3.4.3 Conventions used in station machines..... | 67 |
| 4 Application layer protocol specification for common protocols..... | 72 |
| 4.1 FAL syntax description..... | 72 |
| 4.1.1 DLPDU abstract syntax reference | 72 |
| 4.1.2 Data types..... | 74 |
| 4.2 Transfer syntax..... | 75 |
| 4.2.1 Coding of basic data types | 75 |
| 4.2.2 Coding section related to common basic fields | 83 |
| 4.3 Discovery and basic configuration..... | 94 |
| 4.3.1 DCP syntax description | 94 |
| 4.3.2 DCP protocol state machines..... | 122 |
| 4.3.3 DLL Mapping Protocol Machines..... | 139 |
| 4.4 Precision working time control | 140 |
| 4.4.1 FAL syntax description | 140 |
| 4.4.2 AP-Context state machine | 151 |
| 4.4.3 FAL Service Protocol Machines | 151 |
| 4.4.4 Application Relationship Protocol Machines..... | 152 |
| 4.4.5 DLL Mapping Protocol Machines..... | 215 |
| 4.5 Time synchronization | 215 |
| 4.5.1 General | 215 |
| 4.5.2 GlobalTime | 216 |
| 4.5.3 WorkingClock | 216 |
| 4.6 Media redundancy | 217 |

| | | |
|--------|---|-----|
| 4.6.1 | Media redundancy and loop prevention..... | 217 |
| 4.6.2 | Seamless media redundancy | 220 |
| 4.7 | Real time cyclic..... | 220 |
| 4.7.1 | FAL syntax description | 220 |
| 4.7.2 | FAL transfer syntax | 221 |
| 4.7.3 | FAL Service Protocol Machines | 231 |
| 4.7.4 | Application Relationship Protocol Machines..... | 231 |
| 4.7.5 | DLL Mapping Protocol Machines..... | 249 |
| 4.8 | Real time acyclic..... | 249 |
| 4.8.1 | RTA syntax description | 249 |
| 4.8.2 | RTA transfer syntax..... | 250 |
| 4.8.3 | FAL Service Protocol Machines | 254 |
| 4.8.4 | Application Relationship Protocol Machines..... | 254 |
| 4.8.5 | DLL Mapping Protocol Machines..... | 269 |
| 4.9 | Fragmentation..... | 269 |
| 4.9.1 | General | 269 |
| 4.9.2 | FRAG syntax description | 272 |
| 4.9.3 | FRAG transfer syntax | 273 |
| 4.9.4 | FAL Service Protocol Machines | 275 |
| 4.9.5 | Application Relationship Protocol Machines..... | 275 |
| 4.9.6 | DLL Mapping Protocol Machines..... | 275 |
| 4.10 | Remote procedure call | 286 |
| 4.10.1 | General | 286 |
| 4.10.2 | RPC syntax description | 286 |
| 4.10.3 | RPC Transfer syntax | 288 |
| 4.10.4 | FAL Service Protocol Machines | 304 |
| 4.10.5 | Application Relationship Protocol Machines..... | 304 |
| 4.10.6 | DLL Mapping Protocol Machines..... | 305 |
| 4.11 | Link layer discovery | 305 |
| 4.11.1 | General | 305 |
| 4.11.2 | FAL common syntax description | 305 |
| 4.11.3 | LLDP transfer syntax | 307 |
| 4.11.4 | FAL Service Protocol Machines | 317 |
| 4.11.5 | Application Relation Protocol Machines | 317 |
| 4.11.6 | DLL Mapping Protocol Machines..... | 317 |
| 4.12 | Bridge and End Stations..... | 317 |
| 4.12.1 | General | 317 |
| 4.12.2 | Model | 318 |
| 4.12.3 | Traffic Shaping | 333 |
| 4.12.4 | Bridge extensions | 334 |
| 4.12.5 | QueueHandler | 335 |
| 4.12.6 | FAL Service Protocol Machines | 335 |
| 4.12.7 | Application Relation Protocol Machines | 335 |
| 4.12.8 | DLL Mapping Protocol Machines..... | 335 |
| 4.13 | IP suite | 374 |
| 4.13.1 | Overview | 374 |
| 4.13.2 | IP/UDP syntax description | 374 |
| 4.13.3 | IP/UDP transfer syntax | 375 |
| 4.13.4 | ARP..... | 378 |

| | | |
|--------|---|-----|
| 4.14 | Domain name system..... | 380 |
| 4.14.1 | General | 380 |
| 4.14.2 | Primitive definitions | 380 |
| 4.14.3 | DNS state transition diagram | 381 |
| 4.14.4 | State machine description | 381 |
| 4.14.5 | DNS state table | 381 |
| 4.14.6 | Functions, Macros, Timers and Variables | 381 |
| 4.15 | Dynamic host configuration | 381 |
| 4.15.1 | General | 381 |
| 4.15.2 | Primitive definitions | 382 |
| 4.15.3 | DHCP state transition diagram..... | 382 |
| 4.15.4 | State machine description | 382 |
| 4.15.5 | DHCP state table | 382 |
| 4.15.6 | Functions, Macros, Timers and Variables | 382 |
| 4.16 | Simple network management | 383 |
| 4.16.1 | Overview | 383 |
| 4.16.2 | IETF RFC 1213-MIB | 383 |
| 4.16.3 | Enterprise number for PNIO MIB | 383 |
| 4.16.4 | MIB cross reference | 384 |
| 4.16.5 | Behavior in case of modular built bridges | 384 |
| 4.16.6 | LLDP EXT MIB | 384 |
| 4.17 | Common DLL Mapping Protocol Machines | 384 |
| 4.17.1 | Overview | 384 |
| 4.17.2 | Data Link Layer Mapping Protocol Machine | 385 |
| 4.18 | Additional definitions..... | 390 |
| 5 | Application layer protocol specification for decentralized periphery..... | 390 |
| 5.1 | FAL syntax description..... | 390 |
| 5.1.1 | DLPDU abstract syntax reference | 390 |
| 5.1.2 | APDU abstract syntax | 390 |
| 5.2 | Transfer syntax..... | 409 |
| 5.2.1 | Coding section related to BlockHeader specific fields | 409 |
| 5.2.2 | Coding section related to RTA-SDU specific fields..... | 424 |
| 5.2.3 | Coding section related to common address fields | 429 |
| 5.2.4 | Coding section related to AL services | 445 |
| 5.2.5 | Coding section related to ARVendorBlock..... | 479 |
| 5.2.6 | Coding section related to PNIOStatus..... | 481 |
| 5.2.7 | Coding section related to I&M Records | 498 |
| 5.2.8 | Coding section related to Alarm and Diagnosis PDUs | 505 |
| 5.2.9 | Coding section related to upload and retrieval | 527 |
| 5.2.10 | Coding section related to iParameter | 527 |
| 5.2.11 | Coding section related to Physical Device Interface Data | 528 |
| 5.2.12 | Coding section related to Physical Device Port Data..... | 528 |
| 5.2.13 | Coding section related to Physical Device IR Data..... | 531 |
| 5.2.14 | Coding section related to Physical Sync Data | 554 |
| 5.2.15 | Coding section related to Isochrone Mode Data | 559 |
| 5.2.16 | Coding section related to Physical Time Data | 561 |
| 5.2.17 | Coding section related to Media Redundancy | 564 |
| 5.2.18 | Coding section related to fiber optics | 575 |
| 5.2.19 | Coding section related to network components | 577 |

| | | |
|-----------------------|---|-----|
| 5.2.20 | Coding section related port statistic | 578 |
| 5.2.21 | Coding section related to fast startup..... | 581 |
| 5.2.22 | Coding section related to DFP | 583 |
| 5.2.23 | Coding section related to MRPD | 587 |
| 5.2.24 | Coding section related to auto configuration | 588 |
| 5.2.25 | Coding section related to controller to controller communication..... | 591 |
| 5.2.26 | Coding section related to system redundancy | 592 |
| 5.2.27 | Coding section related to energy saving | 595 |
| 5.2.28 | Coding section related to asset management..... | 595 |
| 5.2.29 | Coding section related to reporting system | 600 |
| 5.2.30 | Coding section related to Logbook..... | 606 |
| 5.2.31 | Coding section related to Time | 607 |
| 5.2.32 | Coding section related to Channel Related Process Alarm Reason | 607 |
| 5.2.33 | PDU checking rules | 610 |
| 5.3 | FAL protocol state machines..... | 643 |
| 5.3.1 | Overall structure | 643 |
| 5.4 | AP-Context state machine..... | 645 |
| 5.5 | FAL Service Protocol Machines | 645 |
| 5.5.1 | Overview | 645 |
| 5.5.2 | FAL Service Protocol Machine Device | 645 |
| 5.5.3 | FAL Service Protocol Machine Controller..... | 654 |
| 5.6 | Application Relationship Protocol Machines..... | 665 |
| 5.6.1 | Alarm Protocol Machine Initiator | 665 |
| 5.6.2 | Alarm Protocol Machine Responder | 669 |
| 5.6.3 | Device | 673 |
| 5.6.4 | Controller | 756 |
| 5.7 | DLL Mapping Protocol Machines..... | 818 |
| Annex A (normative) | Unified establishing of an AR for all RT classes | 819 |
| A.1 | General..... | 819 |
| A.2 | AR establishing..... | 820 |
| A.3 | Startup of Alarm transmitter and receiver | 825 |
| Annex B (normative) | Complete establishing of an AR..... | 828 |
| Annex C (informative) | Establishing of a device access AR..... | 831 |
| Annex D (informative) | Establishing of an AR (accelerated procedure)..... | 832 |
| Annex E (informative) | Establishing of an AR (fast startup procedure)..... | 835 |
| Annex F (informative) | Example of the upload, storage and retrieval procedure | 837 |
| Annex G (informative) | OSI reference model layers..... | 839 |
| Annex H (informative) | Overview of the IO controller and the IO device state machines | 840 |
| Annex I (informative) | Priority regeneration | 842 |
| Annex J (informative) | Overview of the PTCP synchronization master hierarchy | 843 |
| Annex K (informative) | Optimization of bandwidth usage..... | 845 |
| Annex L (informative) | Time constraints for bandwidth allocation | 847 |
| Annex M (informative) | Time constraints for the forwarding of a frame | 849 |
| M.1 | Principle | 849 |
| M.2 | Forwarding..... | 849 |
| Annex N (informative) | Principle of dynamic frame packing | 851 |
| Annex O (informative) | Principle of Fragmentation | 855 |

| | |
|--|-----|
| Annex P (informative) MRPD – Principle of seamless media redundancy | 858 |
| Annex Q (normative) Principle of a RED_RELAY without forwarding information in PDIRFrameData | 860 |
| Annex R (informative) Optimization for fast startup without autonegotiation | 863 |
| Annex S (informative) Example of a PrmBegin, PrmEnd and ApplRdy sequence | 866 |
| Annex T (informative) List of supported MIBs | 867 |
| Annex U (informative) Structure and content of BLOB | 868 |
| Annex V (normative) LLDP EXT MIB | 869 |
| Annex W (normative) Cross reference to the IEC 62439-2 | 887 |
| W.1 Cross reference to the IEC 62439-2 | 887 |
| W.1.1 General | 887 |
| W.1.2 Ring | 887 |
| W.1.3 Interconnection | 888 |
| Annex X (normative) Maintaining statistic counters for Ethernet | 890 |
| X.1 General | 890 |
| X.2 Counting model | 890 |
| X.3 Explanation of the IETF RFC defined statistic counters | 892 |
| X.4 Value range of the IETF RFC defined statistic counters | 893 |
| Bibliography | 894 |
| Figure 1 – Common structure of specific fields for octet 1 (high) | 60 |
| Figure 2 – Common structure of specific fields for octet 2 | 60 |
| Figure 3 – Common structure of specific fields for octet 3 | 60 |
| Figure 4 – Common structure of specific fields for octet 4 | 61 |
| Figure 5 – Common structure of specific fields for octet 5 | 61 |
| Figure 6 – Common structure of specific fields for octet 6 | 61 |
| Figure 7 – Common structure of specific fields for octet 7 | 62 |
| Figure 8 – Common structure of specific fields for octet 8 | 62 |
| Figure 9 – Common structure of specific fields for octet 9 | 62 |
| Figure 10 – Common structure of specific fields for octet 10 | 63 |
| Figure 11 – Common structure of specific fields for octet 11 | 63 |
| Figure 12 – Common structure of specific fields for octet 12 | 63 |
| Figure 13 – Common structure of specific fields for octet 13 | 64 |
| Figure 14 – Common structure of specific fields for octet 14 | 64 |
| Figure 15 – Common structure of specific fields for octet 15 | 64 |
| Figure 16 – Common structure of specific fields for octet 16 (low) | 65 |
| Figure 17 – Coding of the data type BinaryDate | 77 |
| Figure 18 – Encoding of TimeOfDay with date indication value | 77 |
| Figure 19 – Encoding of TimeOfDay without date indication value | 78 |
| Figure 20 – Encoding of TimeDifference with date indication value | 78 |
| Figure 21 – Encoding of TimeDifference without date indication value | 78 |
| Figure 22 – Encoding of a NetworkTime value | 79 |
| Figure 23 – Encoding of NetworkTimeDifference value | 79 |
| Figure 24 – Encoding of TimeStamp value | 80 |

| | |
|---|-----|
| Figure 25 – Encoding of TimeStampDifference value | 81 |
| Figure 26 – Encoding of TimeStampDifferenceShort value..... | 82 |
| Figure 27 – FastForwardingMulticastMACAdd..... | 88 |
| Figure 28 – State transition diagram of DCPUCS..... | 123 |
| Figure 29 – State transition diagram of DCPUCR..... | 127 |
| Figure 30 – State transition diagram of DCPMCS..... | 131 |
| Figure 31 – State transition diagram of DCPMCR | 134 |
| Figure 32 – State transition diagram of DCPHMCS | 137 |
| Figure 33 – State transition diagram of DCPHMCR..... | 139 |
| Figure 34 – PTCP_SequenceID value range | 141 |
| Figure 35 – Timescale correspondence between PTCP_Time and CycleCounter | 147 |
| Figure 36 – Message timestamp point..... | 152 |
| Figure 37 – Timer model..... | 152 |
| Figure 38 – Four message timestamps | 153 |
| Figure 39 – Line delay protocol with follow up..... | 154 |
| Figure 40 – Line delay protocol without follow up..... | 154 |
| Figure 41 – Line delay measurement | 156 |
| Figure 42 – Model parameter for GSDML usage | 158 |
| Figure 43 – Bridge delay measurement..... | 159 |
| Figure 44 – Delay accumulation..... | 160 |
| Figure 45 – Worst case accumulated time deviation of synchronization | 161 |
| Figure 46 – Signal generation for measurement of deviation | 161 |
| Figure 47 – Measurement of deviation | 162 |
| Figure 48 – PTCP master sending Sync Frame without Follow Up-Frame | 163 |
| Figure 49 – PTCP master sending Sync Frame with FollowUp-Frame..... | 163 |
| Figure 50 – !FU Sync Slave Forwarding Sync-Frame | 164 |
| Figure 51 – FU Sync Slave Forwarding Sync- and FollowUp-Frame..... | 165 |
| Figure 52 – FU Sync Slave Forwarding Sync- and Generating FollowUp-Frame..... | 166 |
| Figure 53 – Principle of the monitoring of the line delay measurement..... | 167 |
| Figure 54 – State transition diagram of DELAY_REQ..... | 169 |
| Figure 55 – State transition diagram of DELAY_RSP | 177 |
| Figure 56 – Overview of PTCP..... | 181 |
| Figure 57 – State transition diagram of SYN_BMA..... | 184 |
| Figure 58 – State transition diagram of SYN_MPSM | 193 |
| Figure 59 – State transition diagram of SYN_SPSM..... | 199 |
| Figure 60 – State transition diagram of SYNC_RELAY..... | 206 |
| Figure 61 – State transition diagram of SCHEDULER | 212 |
| Figure 62 – GlobalTime timer model | 216 |
| Figure 63 – WorkingClock timer model..... | 217 |
| Figure 64 – Media redundancy – Ring..... | 217 |
| Figure 65 – Media redundancy – Interconnection..... | 219 |
| Figure 66 – CycleCounter value range | 222 |
| Figure 67 – Structure of the CycleCounter | 223 |

| | |
|---|-----|
| Figure 68 – Optimized CycleCounter setting | 224 |
| Figure 69 – SFCRC16 generation rule | 228 |
| Figure 70 – SFCycleCounter value range..... | 229 |
| Figure 71 – Basic structure of a PPM with frame structure | 232 |
| Figure 72 – Basic structure of a PPM with subframe structure..... | 233 |
| Figure 73 – State transition diagram of PPM..... | 235 |
| Figure 74 – Basic structure of a CPM..... | 239 |
| Figure 75 – State transition diagram of CPM..... | 241 |
| Figure 76 – Addressing scheme of RTA..... | 251 |
| Figure 77 – Structure of the APM..... | 255 |
| Figure 78 – Structure of the APMS..... | 256 |
| Figure 79 – State transition diagram of APMS..... | 258 |
| Figure 80 – Structure of the APMR | 263 |
| Figure 81 – State transition diagram of APMR | 265 |
| Figure 82 – State transition diagram of FRAG_D | 276 |
| Figure 83 – State transition diagram of FRAG_S..... | 280 |
| Figure 84 – State transition diagram of DEFRAG | 283 |
| Figure 85 – DLL Mapping Protocol Machines (DMPM) | 317 |
| Figure 86 – Principle traffic flow model of a bridge..... | 322 |
| Figure 87 – Principle resource model of a bridge | 323 |
| Figure 88 – End station – on port bridge – transmit..... | 328 |
| Figure 89 – End station – on port bridge – receive..... | 329 |
| Figure 90 – Bridge with End Station..... | 330 |
| Figure 91 – Transmit – one port of a bridge | 330 |
| Figure 92 – Forwarding process – bridge | 331 |
| Figure 93 – Receive – on port of a bridge | 331 |
| Figure 94 – Transmit – Management port..... | 332 |
| Figure 95 – Receive – Management port..... | 333 |
| Figure 96 – State transition diagram of RTC3PSM | 339 |
| Figure 97 – State transition diagram for generating events | 343 |
| Figure 98 – State transition diagram of RED_RELAY | 345 |
| Figure 99 – Scheme of the DFP_RELAY | 349 |
| Figure 100 – Scheme of the DFP_RELAY_INBOUND and DFP_RELAY_IN_STORAGE | 349 |
| Figure 101 – Scheme of the DFP_RELAY_OUTBOUND..... | 350 |
| Figure 102 – State transition diagram of DFP_RELAY | 351 |
| Figure 103 – State transition diagram of DFP_RELAY_INBOUND | 354 |
| Figure 104 – State transition diagram of DFP_RELAY_IN_STORAGE..... | 358 |
| Figure 105 – State transition diagram of DFP_RELAY_OUTBOUND | 362 |
| Figure 106 – State transition diagram of MUX..... | 366 |
| Figure 107 – State transition diagram of DEMUX | 371 |
| Figure 108 – State transition diagram of ACCM | 379 |
| Figure 109 – Structuring of the protocol machines within the DMPM (bridge)..... | 385 |
| Figure 110 – State transition diagram of LMPM..... | 388 |

| | |
|--|-----|
| Figure 111 – AlarmSpecifier.SequenceNumber value range | 427 |
| Figure 112 – FrameSendOffset vs. duration of a cycle | 472 |
| Figure 113 – Severity classification of fault, maintenance and normal | 526 |
| Figure 114 – Calculation principle for a cycle | 548 |
| Figure 115 – Calculation principle for the minimum YellowTime | 549 |
| Figure 116 – Definition of the reserved interval | 556 |
| Figure 117 – Toplevel view to the PLL window | 559 |
| Figure 118 – Definition of PLL window | 559 |
| Figure 119 – Toplevel view to the time PLL window | 562 |
| Figure 120 – Definition of time PLL window | 563 |
| Figure 121 – Detection of dropped frames – appear | 578 |
| Figure 122 – Detection of dropped frames – disappear | 578 |
| Figure 123 – Detection of DFP late error – appear and disappear | 586 |
| Figure 124 – MediaRedundancyWatchDog expired – appear and disappear | 588 |
| Figure 125 – EndPoint1 and Endpoint2 scheme – above and below | 593 |
| Figure 126 – EndPoint1 and Endpoint2 scheme – left and right | 593 |
| Figure 127 – Relationship among Protocol Machines | 643 |
| Figure 128 – State transition diagram of ALPMI | 666 |
| Figure 129 – State transition diagram of ALPMR | 670 |
| Figure 130 – Scheme of the IO device CM | 674 |
| Figure 131 – State transition diagram of the IO device CM | 676 |
| Figure 132 – State transition diagram of CMDEV | 680 |
| Figure 133 – Scheme of the IO device CM – device access | 685 |
| Figure 134 – State transition diagram of CMDEV_DA | 687 |
| Figure 135 – State transition diagram of CMSU | 691 |
| Figure 136 – State transition diagram of CMIO | 696 |
| Figure 137 – State transition diagram of CMRS | 699 |
| Figure 138 – State transition diagram of CMWRR | 702 |
| Figure 139 – State transition diagram of CMRDR | 707 |
| Figure 140 – State transition diagram of CMSM | 709 |
| Figure 141 – State transition diagram of CMPBE | 713 |
| Figure 142 – State transition diagram of CMDMC | 718 |
| Figure 143 – State transition diagram of CMINA | 723 |
| Figure 144 – State transition diagram of CMRPC | 734 |
| Figure 145 – Intersection and residual amount using different ARUUID.ConfigIDs | 740 |
| Figure 146 – Intersection and removed amount using different ARUUID.ConfigIDs | 741 |
| Figure 147 – State transition diagram of CMSRL | 742 |
| Figure 148 – Single Input and single Output buffer of CMSRL | 748 |
| Figure 149 – Dynamic reconfiguration with CMSRL | 749 |
| Figure 150 – Alarm queue management of CMSRL | 750 |
| Figure 151 – Reporting System management of CMSRL | 751 |
| Figure 152 – Primary: Switchover time between two ARs of an ARset | 751 |
| Figure 153 – Backup: Switchover time between two ARs of an ARset | 752 |

| | |
|--|-----|
| Figure 154 – State transition diagram of CMSRL_AL | 754 |
| Figure 155 – Scheme of the IO controller CM | 757 |
| Figure 156 – State transition diagram of the IO controller CM | 758 |
| Figure 157 – State transition diagram of CMCTL..... | 762 |
| Figure 158 – State transition diagram of CTLSM..... | 769 |
| Figure 159 – State transition diagram of CTLIO | 771 |
| Figure 160 – State transition diagram of CTRLDI | 775 |
| Figure 161 – State transition diagram of CTRLDR..... | 778 |
| Figure 162 – State transition diagram of CTRLRPC..... | 782 |
| Figure 163 – State transition diagram of CTLSU | 787 |
| Figure 164 – State transition diagram of CTLWRI | 792 |
| Figure 165 – State transition diagram of CTLWRR..... | 796 |
| Figure 166 – State transition diagram of CTLPBE | 799 |
| Figure 167 – State transition diagram of CTLDINA..... | 805 |
| Figure 168 – Automatic NameOfStation assignment..... | 810 |
| Figure 169 – State transition diagram of CTLSRL | 812 |
| Figure 170 – Input and Output buffer of CTLSRL | 816 |
| Figure 171 – Input and Output buffer with dynamic reconfiguration | 816 |
| Figure 172 – Alarm queue management of CTLSRL..... | 817 |
| Figure 173 – Alarm queue management with dynamic reconfiguration | 818 |
| Figure A.1 – Establishing of an AR using RT_CLASS_1, RT_CLASS_2 or RT_CLASS_3 (Initial connection monitoring w/o RT)..... | 820 |
| Figure A.2 – Establishing of an AR using RT_CLASS_1, RT_CLASS_2 or RT_CLASS_3 (Connection monitoring with RT) | 821 |
| Figure A.3 – Principle of the data evaluation during startup (delayed RED channel establishment) | 822 |
| Figure A.4 – Principle of the data evaluation during startup (immediate RED channel establishment) | 823 |
| Figure A.5 – Principle of the data evaluation during startup (Special case: Isochronous mode application) | 824 |
| Figure A.6 – Startup of Alarm transmitter and receiver without System Redundancy..... | 825 |
| Figure A.7 – Startup of Alarm transmitter and receiver with System Redundancy..... | 826 |
| Figure A.8 – Startup of Alarm transmitter and receiver during a PrmBegin / PrmEnd / ApplRdy sequence..... | 827 |
| Figure B.1 – Establishing of an AR using RT_CLASS_3 AR with startup mode “Legacy” | 829 |
| Figure B.2 – Establishing of an AR using RT_CLASS_1, 2 or UDP AR with startup mode “Legacy” | 830 |
| Figure C.1 – Establishing of a device access AR | 831 |
| Figure D.1 – Accelerated establishing of an IOAR without error | 833 |
| Figure D.2 – Accelerated establishing of an IOAR with “late” error | 834 |
| Figure E.1 – Establishing of an IOAR using fast startup | 836 |
| Figure F.1 – Example of upload with storage | 837 |
| Figure F.2 – Example of retrieval with storage | 838 |
| Figure G.1 – Assignment of the OSI reference model layers | 839 |
| Figure H.1 – Overview of the IO controller state machines..... | 840 |

| | |
|--|-----|
| Figure H.2 – Overview of the IO device state machines | 840 |
| Figure H.3 – Overview of the common state machines | 841 |
| Figure J.1 – Level model for synchronization master hierarchy | 843 |
| Figure J.2 – Two level variant of the synchronization master hierarchy | 844 |
| Figure K.1 – Devices build up in a linear structure | 845 |
| Figure K.2 – Propagation of frames in linear transmit direction | 845 |
| Figure K.3 – Propagation of a frames in receive direction | 846 |
| Figure L.1 – Overview of time constraints for bandwidth allocation..... | 847 |
| Figure L.2 – Calculation of the length of a RED period..... | 847 |
| Figure L.3 – Calculation of the length of a GREEN period..... | 848 |
| Figure M.1 – IEEE 802.3 definition..... | 849 |
| Figure M.2 – Minimization of bridge delay | 849 |
| Figure N.1 – Dynamic frame packing | 851 |
| Figure N.2 – Dynamic frame packing – truncation of outputs..... | 852 |
| Figure N.3 – Dynamic frame packing – concatenation of inputs..... | 852 |
| Figure N.4 – End node mode | 853 |
| Figure N.5 – DFPFeed definition | 853 |
| Figure O.1 – Principle of fragmentation..... | 855 |
| Figure O.2 – Protocol elements of fragments | 855 |
| Figure O.3 – Bandwidth allocation using fragmentation..... | 856 |
| Figure O.4 – Guardian for a fragmentation domain..... | 856 |
| Figure P.1 – Principle of seamless media redundancy – I/OCR..... | 858 |
| Figure P.2 – Principle of seamless media redundancy – MCR..... | 859 |
| Figure P.3 – Principle of seamless media redundancy – Line..... | 859 |
| Figure Q.1 – Generating the FrameSendOffset for a RED_RELAY without forwarding information in PDIRFrameData | 860 |
| Figure R.1 – Scheme of a 2-port switch | 863 |
| Figure R.2 – Scheme of 2-ports | 863 |
| Figure S.1 – PrmBegin, PrmEnd and ApplRdy procedure | 866 |
| Figure X.1 – IEEE 802 structure used for statistic counters..... | 891 |
| Figure X.2 – IEEE 802 summary for statistic counters..... | 892 |
| | |
| Table 1 – One octet | 65 |
| Table 2 – Two subsequent octets..... | 66 |
| Table 3 – Four subsequent octets | 66 |
| Table 4 – Eight subsequent octets | 67 |
| Table 5 – Sixteen subsequent octets | 67 |
| Table 6 – State machine description elements | 68 |
| Table 7 – Description of state machine elements | 68 |
| Table 8 – Conventions used in state machines | 69 |
| Table 9 – Conventions for services used in state machines | 70 |
| Table 10 – IEEE 802.3 DLPDU syntax | 72 |
| Table 11 – IEEE 802.11 DLPDU syntax | 73 |

| | |
|---|----|
| Table 12 – IEEE 802.15.1 DLPDU syntax | 74 |
| Table 13 – Status | 79 |
| Table 14 – Time source | 81 |
| Table 15 – SourceAddress..... | 83 |
| Table 16 – Single port device..... | 83 |
| Table 17 – DCP_MulticastMACAdd for Identify | 84 |
| Table 18 – DCP_MulticastMACAdd for Hello..... | 84 |
| Table 19 – DCP_MulticastMACAdd | 84 |
| Table 20 – MulticastMACAdd range 1 | 84 |
| Table 21 – MulticastMACAdd range 2 | 84 |
| Table 22 – MulticastMACAdd range 3 | 85 |
| Table 23 – PTCP_MulticastMACAdd range 2 | 85 |
| Table 24 – PTCP_MulticastMACAdd range 3 | 85 |
| Table 25 – PTCP_MulticastMACAdd range 4 | 85 |
| Table 26 – PTCP_MulticastMACAdd range 5 | 86 |
| Table 27 – PTCP_MulticastMACAdd range 6 | 86 |
| Table 28 – PTCP_MulticastMACAdd range 7 | 86 |
| Table 29 – MulticastMACAdd range 8 | 86 |
| Table 30 – MulticastMACAdd range 9 | 86 |
| Table 31 – MulticastMACAdd range 10 | 87 |
| Table 32 – MulticastMACAdd range 11 | 87 |
| Table 33 – RT_CLASS_3 destination multicast address | 88 |
| Table 34 – RT_CLASS_3 invalid frame multicast address | 89 |
| Table 35 – LT (Length/Type)..... | 89 |
| Table 36 – TagControllInformation.VID | 89 |
| Table 37 – TagControllInformation.DEI | 90 |
| Table 38 – TagControllInformation.PCP..... | 90 |
| Table 39 – FrameID range 1 | 90 |
| Table 40 – FrameID range 2 | 91 |
| Table 41 – FrameID range 3 | 91 |
| Table 42 – FrameID range 4 | 91 |
| Table 43 – FrameID range 5 | 91 |
| Table 44 – FrameID range 6 | 92 |
| Table 45 – FrameID range 7 | 92 |
| Table 46 – FrameID range 8 | 92 |
| Table 47 – FrameID range 9 | 93 |
| Table 48 – FrameID range 10 | 93 |
| Table 49 – FrameID range 11 | 93 |
| Table 50 – FrameID range 12 | 93 |
| Table 51 – FrameID range 13 | 93 |
| Table 52 – FragmentationFrameID.FragSequence | 94 |
| Table 53 – FragmentationFrameID.Constant..... | 94 |
| Table 54 – DCP APDU syntax..... | 94 |

| | |
|---|-----|
| Table 55 – DCP substitutions | 95 |
| Table 56 – ServiceID | 98 |
| Table 57 – ServiceType.Selection | 98 |
| Table 58 – ServiceType.Reserved | 98 |
| Table 59 – ServiceType.Selection | 99 |
| Table 60 – ServiceType.Reserved_1 | 99 |
| Table 61 – ServiceType.Response | 99 |
| Table 62 – ServiceType.Reserved_2 | 99 |
| Table 63 – ResponseDelayFactor | 100 |
| Table 64 – List of options | 101 |
| Table 65 – List of suboptions for option IPOption | 102 |
| Table 66 – List of suboptions for option DevicePropertiesOption | 102 |
| Table 67 – List of suboptions for option DHCPOption | 102 |
| Table 68 – List of suboptions for option ControlOption | 103 |
| Table 69 – List of suboptions for option DeviceInitiativeOption | 103 |
| Table 70 – List of suboptions for option AllSelectorOption | 103 |
| Table 71 – List of suboptions for option ManufacturerSpecificOption | 103 |
| Table 72 – SuboptionDHCP | 105 |
| Table 73 – Coding of DCPBlockLength in conjunction with SuboptionStart | 106 |
| Table 74 – Coding of DCPBlockLength in conjunction with SuboptionStop | 106 |
| Table 75 – Coding of DCPBlockLength in conjunction with SuboptionSignal | 106 |
| Table 76 – Coding of DCPBlockLength in conjunction with SuboptionFactoryReset | 107 |
| Table 77 – Alignment between FactoryReset and ResetToFactory | 107 |
| Table 78 – Coding of DCPBlockLength in conjunction with SuboptionResetToFactory | 107 |
| Table 79 – Meaning of the different ResetToFactory modes | 108 |
| Table 80 – Coding of DCPBlockLength in conjunction with SuboptionDeviceInitiative | 108 |
| Table 81 – Coding of DCPBlockLength | 109 |
| Table 82 – BlockQualifier with options IPOption, DevicePropertiesOption, DHCPOption and ManufacturerSpecificOption | 109 |
| Table 83 – BlockQualifier with option ControlOption and suboption SuboptionResetToFactory | 110 |
| Table 84 – BlockQualifier with option ControlOption and NOT suboption SuboptionResetToFactory | 111 |
| Table 85 – BlockError | 111 |
| Table 86 – BlockInfo for SuboptionIPParameter | 111 |
| Table 87 – Bit 1 and Bit 0 of BlockInfo for SuboptionIPParameter | 112 |
| Table 88 – Bit 7 of BlockInfo for SuboptionIPParameter | 112 |
| Table 89 – BlockInfo for all other suboptions | 112 |
| Table 90 – DeviceInitiativeValue | 112 |
| Table 91 – SignalValue | 113 |
| Table 92 – DeviceRoleDetails | 115 |
| Table 93 – IPAddress | 115 |
| Table 94 – Subnetmask | 117 |
| Table 95 – StandardGateway | 118 |

| | |
|---|-----|
| Table 96 – Correlation between the subfields of IPsuite | 119 |
| Table 97 – MACAddress as client identifier | 120 |
| Table 98 – NameOfStation as client identifier | 120 |
| Table 99 – Arbitrary client identifier | 120 |
| Table 100 – DHCPParameterValue using DHCP Option 255 | 121 |
| Table 101 – StandardGatewayValue.StandardGateway | 122 |
| Table 102 – Remote primitives issued or received by DCPUCS | 122 |
| Table 103 – Local primitives issued or received by DCPUCS | 123 |
| Table 104 – DCPUCS state table | 124 |
| Table 105 – Functions, Macros, Timers and Variables used by the DCPUCS | 126 |
| Table 106 – Remote primitives issued or received by DCPUCR | 127 |
| Table 107 – Local primitives issued or received by DCPUCR | 127 |
| Table 108 – DCPUCR state table | 128 |
| Table 109 – Functions, Macros, Timers and Variables used by the DCPUCR | 130 |
| Table 110 – Remote primitives issued or received by DCPMCS | 130 |
| Table 111 – Local primitives issued or received by DCPMCS | 131 |
| Table 112 – DCPMCS state table | 132 |
| Table 113 – Functions used by the DCPMCS | 133 |
| Table 114 – Remote primitives issued or received by DCPMCR | 134 |
| Table 115 – Local primitives issued or received by DCPMCR | 134 |
| Table 116 – DCPMCR state table | 135 |
| Table 117 – Functions, Macros, Timers and Variables used by the DCPMCR | 136 |
| Table 118 – Remote primitives issued or received by DCPHMCS | 136 |
| Table 119 – Local primitives issued or received by DCPHMCS | 137 |
| Table 120 – DCPHMCS state table | 137 |
| Table 121 – Functions, Macros, Timers and Variables used by the DCPHMCS | 138 |
| Table 122 – Remote primitives issued or received by DCPHMCR | 138 |
| Table 123 – Local primitives issued or received by DCPHMCR | 138 |
| Table 124 – DCPHMCR state table | 139 |
| Table 125 – Functions, Macros, Timers and Variables used by the DCPHMCR | 139 |
| Table 126 – PTCP APDU syntax | 140 |
| Table 127 – PTCP substitutions | 140 |
| Table 128 – PTCP_TLVHeader.Type | 141 |
| Table 129 – PTCP_Delay10ns | 142 |
| Table 130 – PTCP_Delay1ns_Byte.Value | 142 |
| Table 131 – PTCP_Delay1ns | 143 |
| Table 132 – PTCP_Delay1ns_FUP | 143 |
| Table 133 – PTCP_SequenceID | 143 |
| Table 134 – PTCP_SubType for OUI (=00-0E-CF) | 144 |
| Table 135 – PTCP_Seconds | 145 |
| Table 136 – PTCP_NanoSeconds | 145 |
| Table 137 – PTCP_Flags.LeapSecond | 145 |

| | |
|---|-----|
| Table 138 – Timescale correspondence between PTCP_EPOCHNUMBER, PTCP_Second, PTCP_Nanosecond, CycleCounter and SendClockFactor | 146 |
| Table 139 – PTCP_CurrentUTCOffset..... | 148 |
| Table 140 – PTCP_MasterPriority1.Priority for SyncID == 0 and SyncProperties.Role == 2 | 148 |
| Table 141 – PTCP_MasterPriority1.Priority for SyncID == 0 and SyncProperties.Role == 1 | 148 |
| Table 142 – PTCP_MasterPriority1.Level..... | 149 |
| Table 143 – PTCP_MasterPriority2 | 149 |
| Table 144 – PTCP_ClockClass for SyncID == 0 (working clock synchronization) | 149 |
| Table 145 – PTCP_ClockAccuracy..... | 150 |
| Table 146 – PTCP_ClockVariance | 151 |
| Table 147 – PTCP_T2PortRxDelay | 151 |
| Table 148 – PTCP_T3PortTxDelay | 151 |
| Table 149 – PTCP_T2TimeStamp | 151 |
| Table 150 – Remote primitives issued or received by DELAY_REQ | 168 |
| Table 151 – Local primitives issued or received by DELAY_REQ | 168 |
| Table 152 – DELAY_REQ state table | 170 |
| Table 153 – Functions, macros, timers and variables used by the DELAY_REQ | 174 |
| Table 154 – Remote primitives issued or received by DELAY_RSP..... | 176 |
| Table 155 – Local primitives issued or received by DELAY_RSP | 176 |
| Table 156 – DELAY_RSP state table | 178 |
| Table 157 – Functions, Macros, Timers and Variables used by the DELAY_RSP | 180 |
| Table 158 – Remote primitives issued or received by SYN_BMA | 182 |
| Table 159 – Local primitives issued or received by SYN_BMA | 182 |
| Table 160 – SYN_BMA state table | 185 |
| Table 161 – Functions, Macros, Timers and Variables used by the SYN_BMA..... | 189 |
| Table 162 – Remote primitives issued or received by SYN_MPSM..... | 192 |
| Table 163 – Local primitives issued or received by SYN_MPSM | 192 |
| Table 164 – SYN_MPSM state table | 194 |
| Table 165 – Functions, Macros, Timers and Variables used by the SYN_MPSM | 197 |
| Table 166 – Remote primitives issued or received by SYN_SPSM | 198 |
| Table 167 – Local primitives issued or received by SYN_SPSM..... | 198 |
| Table 168 – SYN_SPSM state table..... | 200 |
| Table 169 – Functions, Macros, Timers and Variables used by the SYN_SPSM..... | 203 |
| Table 170 – Truth table for one SyncID for receiving sync and follow up frames | 204 |
| Table 171 – Remote primitives issued or received by SYNC_RELAY | 205 |
| Table 172 – Local primitives issued or received by SYNC_RELAY..... | 205 |
| Table 173 – SYNC_RELAY state table..... | 207 |
| Table 174 – Functions, Macros, Timers and Variables used by the SYNC_RELAY..... | 208 |
| Table 175 – Truth table for one SyncID for receiving..... | 210 |
| Table 176 – Truth table for one SyncID for transmitting | 211 |
| Table 177 – Remote primitives issued or received by SCHEDULER..... | 211 |
| Table 178 – Local primitives issued or received by SCHEDULER | 212 |
| Table 179 – SCHEDULER state table | 213 |

| | |
|---|-----|
| Table 180 – Functions, Macros, Timers and Variables used by the SCHEDULER | 214 |
| Table 181 – Truth table for RxPeriodChecker of one port..... | 215 |
| Table 182 – Truth table for TxPeriodChecker of one port | 215 |
| Table 183 – Timescales | 215 |
| Table 184 – Timescale correspondence between GlobalTime, TAI and UTC | 216 |
| Table 185 – Conjunction between supported MRP_Role and default MRP_Prio | 218 |
| Table 186 – Extended forwarding rule..... | 218 |
| Table 187 – Managed Multicast MAC address..... | 219 |
| Table 188 – RTC APDU syntax | 220 |
| Table 189 – RTC substitutions | 221 |
| Table 190 – CycleCounter Difference..... | 222 |
| Table 191 – DataStatus.State | 224 |
| Table 192 – DataStatus.Redundancy in conjunction with DataStatus.State==Backup..... | 225 |
| Table 193 – DataStatus.Redundancy in conjunction with DataStatus.State==Primary | 225 |
| Table 194 – DataStatus.DataValid | 225 |
| Table 195 – DataStatus.ProviderState | 225 |
| Table 196 – DataStatus.StationProblemIndicator | 226 |
| Table 197 – DataStatus.Ignore of a frame..... | 226 |
| Table 198 – DataStatus.Ignore of a sub frame | 226 |
| Table 199 – TransferStatus for RT_CLASS_3 | 227 |
| Table 200 – SFPosition.Position | 228 |
| Table 201 – SFPosition.Reserved | 228 |
| Table 202 – SFDataLength | 228 |
| Table 203 – SFCycleCounter Difference | 230 |
| Table 204 – IOxS.Extension..... | 230 |
| Table 205 – IOxS.Instance..... | 230 |
| Table 206 – IOxS.DataState | 231 |
| Table 207 – APDU_Status of a PPM with subframe structure..... | 233 |
| Table 208 – Remote primitives issued or received by PPM | 234 |
| Table 209 – Local primitives issued or received by PPM..... | 234 |
| Table 210 – PPM state table..... | 236 |
| Table 211 – Functions, Macros, Timers and Variables used by the PPM..... | 237 |
| Table 212 – Truth table used by the PPM for TxOption | 238 |
| Table 213 – Remote primitives issued or received by CPM | 240 |
| Table 214 – Local primitives issued or received by CPM..... | 240 |
| Table 215 – CPM state table..... | 242 |
| Table 216 – Functions, Macros, Timers and Variables used by the CPM..... | 245 |
| Table 217 – Truth table used by the CPM for RxOption..... | 246 |
| Table 218 – Truth table for one frame using RT_CLASS_x | 247 |
| Table 219 – Truth table for one frame using RT_CLASS_UDP | 247 |
| Table 220 – Truth table for the C_SDU | 247 |
| Table 221 – Truth table for arranging DHT and data | 248 |
| Table 222 – Truth table for the subframe – frame check..... | 248 |

| | |
|--|-----|
| Table 223 – Truth table for the subframe – sub frame check | 248 |
| Table 224 – Truth table for the subframe – sub frame data check | 249 |
| Table 225 – Truth table for the subframe – DHT and data | 249 |
| Table 226 – RTA APDU syntax | 249 |
| Table 227 – RTA substitutions | 250 |
| Table 228 – PDUType.Type | 252 |
| Table 229 – PDUType.Version | 252 |
| Table 230 – AddFlags.WindowSize | 252 |
| Table 231 – AddFlags.TACK | 252 |
| Table 232 – SendSeqNum | 253 |
| Table 233 – SendSeqNum and AckSeqNum start sequence | 253 |
| Table 234 – AckSeqNum | 254 |
| Table 235 – VarPartLen | 254 |
| Table 236 – Remote primitives issued or received by APMS | 256 |
| Table 237 – Local primitives issued or received by APMS | 257 |
| Table 238 – APMS state table | 259 |
| Table 239 – Functions, Macros, Timers and Variables used by the APMS | 261 |
| Table 240 – Remote primitives issued or received by APMR | 264 |
| Table 241 – Local primitives issued or received by APMR | 265 |
| Table 242 – APMR state table | 266 |
| Table 243 – Functions, Macros, Timers and Variables used by the APMR | 268 |
| Table 244 – TagControllInformation.PCP vs. streams | 269 |
| Table 245 – Lower limit of fragments | 272 |
| Table 246 – FRAG APDU syntax | 272 |
| Table 247 – FRAG substitutions | 273 |
| Table 248 – FragDataLength | 274 |
| Table 249 – FragStatus.FragmentNumber | 274 |
| Table 250 – FragStatus.Reserved | 274 |
| Table 251 – FragStatus.MoreFollows | 275 |
| Table 252 – Remote primitives issued or received by FRAG_D | 275 |
| Table 253 – Local primitives issued or received by FRAG_D | 275 |
| Table 254 – FRAG_D state table (dynamic) | 277 |
| Table 255 – Functions, Macros, Timers and Variables used by the FRAG_D (dynamic) | 278 |
| Table 256 – Remote primitives issued or received by FRAG_S | 279 |
| Table 257 – Local primitives issued or received by FRAG_S | 279 |
| Table 258 – FRAG_S state table (static) | 281 |
| Table 259 – Functions, Macros, Timers and Variables used by the FRAG_S (static) | 282 |
| Table 260 – Remote primitives issued or received by DEFRAG | 283 |
| Table 261 – Local primitives issued or received by DEFRAG | 283 |
| Table 262 – DEFRAG state table | 284 |
| Table 263 – Functions, Macros, Timers and Variables used by the DEFRAG | 285 |
| Table 264 – Truth table for the DefragGuard – first fragment | 285 |
| Table 265 – Truth table for the DefragGuard – next fragment | 285 |

| | |
|--|-----|
| Table 266 – Truth table for the DefragGuard – last fragment..... | 286 |
| Table 267 – RPC APDU syntax..... | 286 |
| Table 268 – RPC substitutions..... | 287 |
| Table 269 – RPCVersion..... | 288 |
| Table 270 – RPCPacketType..... | 288 |
| Table 271 – RPCFlags..... | 289 |
| Table 272 – RPCFlags2..... | 289 |
| Table 273 – RPCDRRep.Character- and IntegerEncoding..... | 290 |
| Table 274 – RPCDRRep Octet 2 – Floating Point Representation..... | 290 |
| Table 275 – RPCObjectUUID.Data4..... | 291 |
| Table 276 – RPCObjectUUID for devices..... | 291 |
| Table 277 – Instance or node number..... | 291 |
| Table 278 – RPCInterfaceUUID for PNIO..... | 292 |
| Table 279 – RPCInterfaceUUID for the RPC end point mapper..... | 292 |
| Table 280 – RPCInterfaceVersion.Major..... | 293 |
| Table 281 – RPCInterfaceVersion.Minor..... | 293 |
| Table 282 – RPCOperationNmb (IO device, controller and supervisor)..... | 294 |
| Table 283 – RPCOperationNmb for endpoint mapper..... | 294 |
| Table 284 – RPCVersionFack..... | 295 |
| Table 285 – RPCDataRepresentationUUID – defined values..... | 296 |
| Table 286 – RPCInquiryType..... | 298 |
| Table 287 – RPCEPMapStatus..... | 300 |
| Table 288 – Values of NCAFaultStatus..... | 302 |
| Table 289 – Values of NCAREjectStatus..... | 303 |
| Table 290 – Remote primitives issued or received by RPC..... | 304 |
| Table 291 – Local primitives issued or received by RPC..... | 304 |
| Table 292 – LLDP APDU syntax..... | 306 |
| Table 293 – LLDP substitutions..... | 306 |
| Table 294 – LLDP_ChassisID in conjunction with MultipleInterfaceMode.NameOfDevice == 0 and NameOfStation..... | 307 |
| Table 295 – LLDP_ChassisID in conjunction with MultipleInterfaceMode.NameOfDevice == 1..... | 307 |
| Table 296 – LLDP_PortID in conjunction with MultipleInterfaceMode.NameOfDevice..... | 308 |
| Table 297 – LLDP_PNIO_SubType..... | 308 |
| Table 298 – PTCP_PortRxDelayLocal..... | 309 |
| Table 299 – PTCP_PortRxDelayRemote..... | 309 |
| Table 300 – PTCP_PortTxDelayLocal..... | 309 |
| Table 301 – PTCP_PortTxDelayRemote..... | 309 |
| Table 302 – CableDelayLocal..... | 310 |
| Table 303 – RTClass2_PortStatus.State with ARProperties.StartupMode == Legacy..... | 310 |
| Table 304 – RTClass2_PortStatus.State with ARProperties.StartupMode == Advanced..... | 310 |
| Table 305 – RTClass3_PortStatus.State..... | 311 |
| Table 306 – RTClass3_PortStatus.Fragmentation..... | 311 |
| Table 307 – RTClass3_PortStatus.PreambleLength..... | 311 |

| | |
|---|-----|
| Table 308 – Truth table for shortening of the preamble | 312 |
| Table 309 – RTClass3_PortStatus.Optimized..... | 312 |
| Table 310 – MRRT_PortStatus.State | 313 |
| Table 311 – IRDataUUID | 313 |
| Table 312 – LLDP_RedOrangePeriodBegin.Offset | 313 |
| Table 313 – LLDP_RedOrangePeriodBegin.Valid..... | 313 |
| Table 314 – LLDP_OrangePeriodBegin.Offset | 314 |
| Table 315 – LLDP_OrangePeriodBegin.Valid with ARProperties.StartupMode == Legacy | 314 |
| Table 316 – LLDP_OrangePeriodBegin.Valid with ARProperties.StartupMode == Advanced | 314 |
| Table 317 – LLDP_GreenPeriodBegin.Offset | 315 |
| Table 318 – LLDP_GreenPeriodBegin.Valid..... | 315 |
| Table 319 – LLDP_LengthOfPeriod.Length | 315 |
| Table 320 – LLDP_LengthOfPeriod.Valid..... | 315 |
| Table 321 – Priority remapping at an ingress boundary port..... | 319 |
| Table 322 – Trees and FDBs | 320 |
| Table 323 – Available queue..... | 322 |
| Table 324 – Queue related memory management | 323 |
| Table 325 – Queue usage..... | 324 |
| Table 326 – Queue usage..... | 324 |
| Table 327 – QB TSA usage..... | 325 |
| Table 328 – QB TSA usage..... | 326 |
| Table 329 – Traffic Classes[0..7] for eight queues | 334 |
| Table 330 – Traffic Classes[0..3] for four queues | 334 |
| Table 331 – Unicast FDB entries | 335 |
| Table 332 – Multicast FDB entries | 336 |
| Table 333 – Broadcast FDB entry | 337 |
| Table 334 – Remote primitives issued or received by MAC_RELAY | 337 |
| Table 335 – Local primitives issued or received by MAC_RELAY..... | 338 |
| Table 336 – Functions, Macros, Timers and Variables used by the MAC_RELAY..... | 338 |
| Table 337 – Remote primitives issued or received by RTC3PSM | 339 |
| Table 338 – Local primitives issued or received by RTC3PSM | 339 |
| Table 339 – RTC3PSM state table | 340 |
| Table 340 – Functions, Macros, Timers and Variables used by the RTC3PSM | 341 |
| Table 341 – Truth table for the RTC3PSM | 342 |
| Table 342 – RXBeginEndAssignment and TXBeginEndAssignment..... | 342 |
| Table 343 – Event function table..... | 343 |
| Table 344 – Remote primitives issued or received by RED_RELAY | 344 |
| Table 345 – Local primitives issued or received by RED_RELAY | 344 |
| Table 346 – RED_RELAY state table | 346 |
| Table 347 – Functions, Macros, Timers and Variables used by the RED_RELAY | 347 |
| Table 348 – Truth table for the RedGuard with full check | 347 |
| Table 349 – Truth table for the RedGuard with reduced check | 348 |

| | |
|--|-----|
| Table 350 – Truth table for the RedGuard with minimal check..... | 348 |
| Table 351 – Remote primitives issued or received by DFP_RELAY..... | 350 |
| Table 352 – Local primitives issued or received by DFP_RELAY..... | 351 |
| Table 353 – DFP_RELAY state table..... | 352 |
| Table 354 – Functions, Macros, Timers and Variables used by the DFP_RELAY..... | 352 |
| Table 355 – Truth table for the DFPGuard..... | 353 |
| Table 356 – Remote primitives issued or received by DFP_RELAY_INBOUND..... | 353 |
| Table 357 – Local primitives issued or received by DFP_RELAY_INBOUND..... | 354 |
| Table 358 – DFP_RELAY_INBOUND state table..... | 355 |
| Table 359 – Functions, Macros, Timers and Variables used by the DFP_RELAY_INBOUND..... | 355 |
| Table 360 – Truth table for the InboundGuard – frame check..... | 356 |
| Table 361 – Truth table for the InboundGuard – sub frame check..... | 356 |
| Table 362 – Truth table for the InboundGuard – sub frame data check..... | 356 |
| Table 363 – Truth table for the InboundGuard – full check..... | 357 |
| Table 364 – Remote primitives issued or received by DFP_RELAY_IN_STORAGE..... | 357 |
| Table 365 – Local primitives issued or received by DFP_RELAY_IN_STORAGE..... | 358 |
| Table 366 – DFP_RELAY_IN_STORAGE state table..... | 359 |
| Table 367 – Functions, Macros, Timers and Variables used by the DFP_RELAY_IN_STORAGE..... | 360 |
| Table 368 – Remote primitives issued or received by DFP_RELAY_OUTBOUND..... | 361 |
| Table 369 – Local primitives issued or received by DFP_RELAY_OUTBOUND..... | 361 |
| Table 370 – APDU_Status used if frame is shortened..... | 362 |
| Table 371 – DFP_RELAY_OUTBOUND state table..... | 363 |
| Table 372 – Functions, Macros, Timers and Variables used by the DFP_RELAY_OUTBOUND..... | 364 |
| Table 373 – Truth table for the OutboundGuard – frame check..... | 364 |
| Table 374 – Truth table for the OutboundGuard – sub frame check..... | 365 |
| Table 375 – Remote primitives issued or received by MUX..... | 365 |
| Table 376 – Local primitives issued or received by MUX..... | 365 |
| Table 377 – MUX state table..... | 367 |
| Table 378 – Functions, Macros, Timers and Variables used by MUX..... | 368 |
| Table 379 – Truth table for FrameSizeFits..... | 369 |
| Table 380 – Truth table for StateChecker..... | 369 |
| Table 381 – Remote primitives issued or received by DEMUX..... | 370 |
| Table 382 – Local primitives issued or received by DEMUX..... | 370 |
| Table 383 – DEMUX state table..... | 372 |
| Table 384 – Functions, Macros, Timers and Variables used by the DEMUX..... | 373 |
| Table 385 – IP/UDP APDU syntax..... | 374 |
| Table 386 – IP/UDP substitutions..... | 375 |
| Table 387 – UDP_SrcPort..... | 376 |
| Table 388 – UDP_DstPort..... | 376 |
| Table 389 – IP_DstIPAddress..... | 376 |
| Table 390 – IP Multicast DstIPAddress according to IETF RFC 2365..... | 376 |

| | |
|---|-----|
| Table 391 – IP_DifferentiatedServices.DSCP..... | 377 |
| Table 392 – IP_DifferentiatedServices.ECN..... | 377 |
| Table 393 – Remote primitives issued or received by ACCM..... | 378 |
| Table 394 – Local primitives issued or received by ACCM..... | 379 |
| Table 395 – ACCM state table..... | 380 |
| Table 396 – Functions, Macros, Timers and Variables used by the ACCM..... | 380 |
| Table 397 – Remote primitives issued or received by DNS..... | 381 |
| Table 398 – Local primitives issued or received by DNS..... | 381 |
| Table 399 – Functions, Macros, Timers and Variables used by the DNS..... | 381 |
| Table 400 – Remote primitives issued or received by DHCP..... | 382 |
| Table 401 – Local primitives issued or received by machines..... | 382 |
| Table 402 – Functions, Macros, Timers and Variables used by the DHCP..... | 383 |
| Table 403 – List of supported IETF RFC 1213-MIB objects..... | 383 |
| Table 404 – Enterprise number..... | 384 |
| Table 405 – Cross reference – MIBs..... | 384 |
| Table 406 – Cross reference – PDPortDataAdjust..... | 384 |
| Table 407 – Remote primitives issued or received by LMPM..... | 386 |
| Table 408 – Local primitives issued or received by LMPM..... | 387 |
| Table 409 – LMPM state table..... | 388 |
| Table 410 – Functions, Macros, Timers and Variables used by the LMPM..... | 389 |
| Table 411 – IO APDU substitutions..... | 391 |
| Table 412 – BlockType..... | 409 |
| Table 413 – BlockLength..... | 422 |
| Table 414 – BlockVersionHigh..... | 423 |
| Table 415 – BlockVersionLow..... | 423 |
| Table 416 – AlarmType..... | 424 |
| Table 417 – AlarmSpecifier.SequenceNumber..... | 427 |
| Table 418 – AlarmSpecifier.SequenceNumber Difference..... | 428 |
| Table 419 – AlarmSpecifier.ChannelDiagnosis..... | 428 |
| Table 420 – AlarmSpecifier.ManufacturerSpecificDiagnosis..... | 428 |
| Table 421 – AlarmSpecifier.SubmoduleDiagnosisState..... | 429 |
| Table 422 – AlarmSpecifier.ARDiagnosticsState..... | 429 |
| Table 423 – API..... | 430 |
| Table 424 – SlotNumber..... | 430 |
| Table 425 – SubslotNumber..... | 430 |
| Table 426 – Index range..... | 431 |
| Table 427 – Expression 1 (subslot specific)..... | 432 |
| Table 428 – Expression 2 (slot specific)..... | 432 |
| Table 429 – Expression 3 (AR specific)..... | 432 |
| Table 430 – Expression 4 (API specific)..... | 432 |
| Table 431 – Expression 5 (device specific)..... | 432 |
| Table 432 – Grouping of DiagnosisData..... | 433 |
| Table 433 – Index (user specific)..... | 434 |

| | |
|--|-----|
| Table 434 – Index (subslot specific)..... | 434 |
| Table 435 – Index (slot specific) | 438 |
| Table 436 – Index (AR specific) | 439 |
| Table 437 – Index (API specific) | 441 |
| Table 438 – Index (device specific)..... | 442 |
| Table 439 – RecordDataLength | 445 |
| Table 440 – ARType | 445 |
| Table 441 – IOCRMulticastMACAdd using RT_CLASS_UDP..... | 446 |
| Table 442 – IOCRMulticastMACAdd using RT_CLASS_x..... | 446 |
| Table 443 – Type 10 OUI..... | 447 |
| Table 444 – ARProperties.State..... | 447 |
| Table 445 – ARProperties.SupervisorTakeoverAllowed..... | 447 |
| Table 446 – ARProperties.ParameterizationServer | 448 |
| Table 447 – ARProperties.DeviceAccess | 448 |
| Table 448 – ARProperties.CompanionAR..... | 448 |
| Table 449 – ARProperties.AcknowledgeCompanionAR | 448 |
| Table 450 – ARProperties.CombinedObjectContainer with ARProperties.StartupMode == Legacy | 449 |
| Table 451 – ARProperties.CombinedObjectContainer with ARProperties.StartupMode == Advanced | 449 |
| Table 452 – ARProperties.StartupMode | 449 |
| Table 453 – ARProperties.PullModuleAlarmAllowed..... | 449 |
| Table 454 – IOCRProperties.RTClass | 450 |
| Table 455 – IOCRTagHeader.IOCRVLANID | 451 |
| Table 456 – IOCRTagHeader.IOUserPriority..... | 451 |
| Table 457 – IOCRType | 451 |
| Table 458 – CMInitiatorActivityTimeoutFactor with ARProperties.DeviceAccess==0..... | 451 |
| Table 459 – CMInitiatorActivityTimeoutFactor with ARProperties.DeviceAccess==1 or ARProperties.StartupMode==1 | 452 |
| Table 460 – CMInitiatorTriggerTimeoutFactor | 452 |
| Table 461 – IODataObjectFrameOffset | 453 |
| Table 462 – IOCSFrameOffset..... | 453 |
| Table 463 – LengthIOCS..... | 454 |
| Table 464 – LengthIOPS..... | 454 |
| Table 465 – LengthData..... | 454 |
| Table 466 – AlarmCRProperties.Priority..... | 455 |
| Table 467 – AlarmCRProperties.Transport..... | 455 |
| Table 468 – AlarmCRTagHeaderHigh.AlarmCRVLANID | 455 |
| Table 469 – AlarmCRTagHeaderHigh.AlarmUserPriority | 456 |
| Table 470 – AlarmCRTagHeaderLow.AlarmCRVLANID | 456 |
| Table 471 – AlarmCRTagHeaderLow.AlarmUserPriority | 456 |
| Table 472 – AlarmSequenceNumber | 456 |
| Table 473 – AlarmCRType | 457 |
| Table 474 – RTATimeoutFactor | 457 |

| | |
|---|-----|
| Table 475 – RTARetries..... | 457 |
| Table 476 – AddressResolutionProperties.Protocol..... | 458 |
| Table 477 – AddressResolutionProperties.Factor..... | 458 |
| Table 478 – MCITimeoutFactor..... | 459 |
| Table 479 – DeviceIDLow and DeviceIDHigh..... | 459 |
| Table 480 – VendorIDLow..... | 460 |
| Table 481 – VendorIDHigh..... | 460 |
| Table 482 – ModuleIdentNumber..... | 460 |
| Table 483 – SubmoduleIdentNumber..... | 461 |
| Table 484 – ARUUID..... | 462 |
| Table 485 – ARUUID in conjunction with ARTYPE==IOCARSR..... | 462 |
| Table 486 – Conjunction between ARUUID.ARnumber and Endpoint1 or Endpoint2..... | 462 |
| Table 487 – ARUUID.ConfigID generation rule..... | 463 |
| Table 488 – TargetARUUID..... | 463 |
| Table 489 – AdditionalValue1 and AdditionalValue2..... | 463 |
| Table 490 – ControlBlockProperties in conjunction with ControlCommand.ApplicationReady with ARProperties.StartupMode==1..... | 463 |
| Table 491 – ControlBlockProperties in conjunction with ControlCommand.ApplicationReady with ARProperties.StartupMode==0..... | 464 |
| Table 492 – ControlBlockProperties in conjunction with the other values of the field ControlCommand..... | 464 |
| Table 493 – ControlCommand.PrmEnd..... | 464 |
| Table 494 – ControlCommand.ApplicationReady..... | 464 |
| Table 495 – ControlCommand.Release..... | 465 |
| Table 496 – ControlCommand.Done..... | 465 |
| Table 497 – ControlCommand.ReadyForCompanion..... | 465 |
| Table 498 – ControlCommand.ReadyForRT_CLASS_3..... | 465 |
| Table 499 – ControlCommand.PrmBegin..... | 465 |
| Table 500 – DataDescription.Type..... | 466 |
| Table 501 – Values of DataLength..... | 466 |
| Table 502 – Values of SendClockFactor..... | 467 |
| Table 503 – Values of ReductionRatio for RT_CLASS_1 and RT_CLASS_2..... | 468 |
| Table 504 – Values of ReductionRatio for RT_CLASS_3 and SendClockFactor ≥ 8..... | 468 |
| Table 505 – Values of ReductionRatio for RT_CLASS_3 and SendClockFactor < 8..... | 468 |
| Table 506 – Values of ReductionRatio in conjunction with a non power of 2 SendClockFactor..... | 468 |
| Table 507 – Values of ReductionRatio for RT_CLASS_UDP..... | 469 |
| Table 508 – Values of Phase..... | 469 |
| Table 509 – Values of Sequence..... | 469 |
| Table 510 – DataHoldFactor of a frame..... | 470 |
| Table 511 – DataHoldFactor of a Subframe..... | 470 |
| Table 512 – Values of FrameSendOffset..... | 471 |
| Table 513 – ModuleState..... | 472 |
| Table 514 – SubmoduleState.AddInfo..... | 473 |

| | |
|---|-----|
| Table 515 – SubmoduleState.Advice..... | 473 |
| Table 516 – SubmoduleState.MaintenanceRequired | 473 |
| Table 517 – SubmoduleState.MaintenanceDemanded | 473 |
| Table 518 – SubmoduleState.Fault | 474 |
| Table 519 – SubmoduleState.ARInfo | 474 |
| Table 520 – SubmoduleState.IdentInfo | 474 |
| Table 521 – SubmoduleState.FormatIndicator..... | 475 |
| Table 522 – SubmoduleProperties.Type..... | 475 |
| Table 523 – SubmoduleProperties.SharedInput | 475 |
| Table 524 – SubmoduleProperties.ReduceInputSubmoduleDataLength | 476 |
| Table 525 – SubmoduleProperties.ReduceOutputSubmoduleDataLength..... | 476 |
| Table 526 – SubmoduleProperties.DiscardIOXS | 476 |
| Table 527 – SubstitutionMode..... | 477 |
| Table 528 – SubstituteActiveFlag..... | 477 |
| Table 529 – InitiatorUDPRTPort..... | 478 |
| Table 530 – ResponderUDPRTPort..... | 478 |
| Table 531 – InitiatorRPCServerPort | 478 |
| Table 532 – ResponderRPCServerPort | 479 |
| Table 533 – MaxAlarmDataLength | 479 |
| Table 534 – APStructureIdentifier with API=0 | 480 |
| Table 535 – APStructureIdentifier with API ≠ 0..... | 480 |
| Table 536 – ExtendedIdentificationVersionHigh | 480 |
| Table 537 – ExtendedIdentificationVersionLow | 480 |
| Table 538 – Values of ErrorCode for negative responses..... | 481 |
| Table 539 – Values of ErrorDecode | 482 |
| Table 540 – Coding of ErrorCode1 with ErrorDecode PNIORW | 482 |
| Table 541 – Coding of ErrorCode2 with ErrorDecode PNIORW | 483 |
| Table 542 – Coding of ErrorCode1 with ErrorDecode:= PNIO | 484 |
| Table 543 – Values of ErrorCode2 for ErrorDecode:= PNIO and ErrorCode1 (part 1)..... | 487 |
| Table 544 – Values of ErrorCode2 for ErrorDecode:= PNIO and ErrorCode1 (part 2 – alarm acknowledge)..... | 490 |
| Table 545 – Values of ErrorCode2 for ErrorDecode:= PNIO and ErrorCode1 (part 3 – machines)..... | 491 |
| Table 546 – Values of ErrorCode2 for ErrorDecode:= PNIO and ErrorCode1 (part 4 – IO controller) | 492 |
| Table 547 – Values of ErrorCode2 for ErrorDecode:= PNIO and ErrorCode1 (part 5 – IO device)..... | 494 |
| Table 548 – Values of ErrorCode2 for ErrorDecode:= PNIO and ErrorCode1 (part 6 – abort reasons) | 495 |
| Table 549 – Values of ErrorCode2 for ErrorDecode:= PNIO and ErrorCode1 (part 7 – Reserved)..... | 498 |
| Table 550 – Coding of ErrorCode1 for ErrorDecode with the value ManufacturerSpecific | 498 |
| Table 551 – Coding of ErrorCode2 for ErrorDecode with the value ManufacturerSpecific | 498 |
| Table 552 – Visible characters..... | 498 |

| | |
|---|-----|
| Table 553 – FactoryReset / ResetToFactory behavior (legacy from IEC 61158-x-3) | 499 |
| Table 554 – FactoryReset / ResetToFactory behavior (default without IEC 61158-x-3 history) | 499 |
| Table 555 – FactoryReset / ResetToFactory behavior if used in conjunction with functional safety submodules | 499 |
| Table 556 – IM_Hardware_Revision | 499 |
| Table 557 – IM_SWRevision_Functional_Enhancement | 500 |
| Table 558 – IM_SWRevision_Bug_Fix | 500 |
| Table 559 – IM_SWRevision_Internal_Change | 500 |
| Table 560 – IM_Revision_Counter | 500 |
| Table 561 – IM_Profile_ID | 501 |
| Table 562 – IM_Profile_Specific_Type in conjunction with IM_Profile_ID == 0x0000 | 501 |
| Table 563 – IM_Profile_Specific_Type in conjunction with IM_Profile_ID range 0x0001 – 0xF6FF | 501 |
| Table 564 – IM_Version_Major | 502 |
| Table 565 – IM_Version_Minor | 502 |
| Table 566 – IM_Supported.I&M1 | 502 |
| Table 567 – IM_Date with time | 504 |
| Table 568 – IM_Date without time | 504 |
| Table 569 – IM_Annotation | 504 |
| Table 570 – IM_OrderID | 505 |
| Table 571 – IM_UniqueIdentifier | 505 |
| Table 572 – UserStructureIdentifier | 506 |
| Table 573 – ChannelErrorType – range 1 | 508 |
| Table 574 – ChannelErrorType – range 2 | 509 |
| Table 575 – ChannelErrorType – range 3 | 509 |
| Table 576 – ChannelErrorType – range 4 | 510 |
| Table 577 – ChannelNumber | 510 |
| Table 578 – ChannelProperties.Type | 511 |
| Table 579 – ChannelProperties.Accumulative | 511 |
| Table 580 – ChannelProperties.Maintenance | 512 |
| Table 581 – Valid combinations within ChannelProperties | 512 |
| Table 582 – Valid combinations for Alarmnotification and RecordDataRead(DiagnosisData) | 513 |
| Table 583 – ChannelProperties.Specifier | 514 |
| Table 584 – ChannelProperties.Direction | 514 |
| Table 585 – ExtChannelErrorType | 514 |
| Table 586 – Allowed combinations of ChannelErrorType, ExtChannelErrorType, and ExtChannelAddValue | 515 |
| Table 587 – ExtChannelErrorType for ChannelErrorType 0 – 0xFF | 515 |
| Table 588 – Additional ExtChannelErrorType for ChannelErrorType 0x0F and 0x10 | 515 |
| Table 589 – ExtChannelErrorType for ChannelErrorType 0x0100 – 0x7FFF | 515 |
| Table 590 – ExtChannelErrorType for ChannelErrorType “Data transmission impossible” | 516 |
| Table 591 – ExtChannelErrorType for ChannelErrorType “Remote mismatch” | 516 |

| | |
|---|-----|
| Table 592 – ExtChannelErrorType for ChannelErrorType “Media redundancy mismatch – Ring” | 517 |
| Table 593 – ExtChannelErrorType for ChannelErrorType “Media redundancy mismatch – Interconnection” | 517 |
| Table 594 – ExtChannelErrorType for ChannelErrorType “Sync mismatch” and for ChannelErrorType “Time mismatch” | 518 |
| Table 595 – ExtChannelErrorType for ChannelErrorType “Isochronous mode mismatch” | 518 |
| Table 596 – ExtChannelErrorType for ChannelErrorType “Multicast CR mismatch” | 518 |
| Table 597 – ExtChannelErrorType for ChannelErrorType “Fiber optic mismatch” | 519 |
| Table 598 – ExtChannelErrorType for ChannelErrorType “Network component function mismatch” | 519 |
| Table 599 – ExtChannelErrorType for ChannelErrorType “Dynamic Frame Packing function mismatch” | 519 |
| Table 600 – ExtChannelErrorType for ChannelErrorType “Media redundancy with planned duplication mismatch” | 520 |
| Table 601 – ExtChannelErrorType for ChannelErrorType “Multiple interface mismatch” | 520 |
| Table 602 – Values for ExtChannelAddValue | 521 |
| Table 603 – Values for “Accumulative Info” | 521 |
| Table 604 – Values for ExtChannelErrorType “Parameter fault detail” | 522 |
| Table 605 – Values for ExtChannelAddValue.Index | 522 |
| Table 606 – Values for ExtChannelAddValue.Offset | 522 |
| Table 607 – Values for ExtChannelErrorType “Consistency fault detail” | 522 |
| Table 608 – Values for ExtChannelAddValue.Index | 523 |
| Table 609 – Values for “Fiber optic mismatch” – “Power Budget” | 523 |
| Table 610 – Values for “Network component function mismatch” – “Frame dropped” | 523 |
| Table 611 – Values for “Remote mismatch” – “Peer CableDelay mismatch” | 524 |
| Table 612 – Values for “Multiple interface mismatch” – “Conflicting MultipleInterfaceMode.NameOfDevice mode” | 524 |
| Table 613 – Values for “Multiple interface mismatch” – “Inactive StandardGateway” | 524 |
| Table 614 – Values for QualifiedChannelQualifier | 525 |
| Table 615 – Values for MaintenanceStatus | 525 |
| Table 616 – URRecordIndex | 527 |
| Table 617 – URRecordLength | 527 |
| Table 618 – iPar_Req_Header | 527 |
| Table 619 – Max_Segm_Size | 527 |
| Table 620 – Transfer_Index | 528 |
| Table 621 – Total_iPar_Size | 528 |
| Table 622 – MultipleInterfaceMode.NameOfDevice | 528 |
| Table 623 – NumberOfPeers in conjunction with PDPortDataCheck | 529 |
| Table 624 – NumberOfPeers in conjunction with PDPortDataReal or PDPortDataRealExtended | 529 |
| Table 625 – LineDelay.Value with LineDelay.FormatIndicator == 0 | 530 |
| Table 626 – LineDelay.Value with LineDelay.FormatIndicator == 1 | 530 |
| Table 627 – LineDelay.FormatIndicator | 531 |
| Table 628 – RxPort | 531 |
| Table 629 – NumberOfTxPortGroups | 531 |

| | |
|---|-----|
| Table 630 – TxPortEntry | 532 |
| Table 631 – FrameDetails.SyncFrame in conjunction with FrameDataProperties.ForwardingMode=="Absolute mode" | 533 |
| Table 632 – FrameDetails.SyncFrame in conjunction with FrameDataProperties.ForwardingMode=="Relative mode" | 533 |
| Table 633 – FrameDetails.MeaningFrameSendOffset | 534 |
| Table 634 – FrameDetails.MediaRedundancyWatchDog | 534 |
| Table 635 – FrameDataProperties.ForwardingMode | 534 |
| Table 636 – FrameDataProperties.FastForwardingMulticastMACAdd | 534 |
| Table 637 – FrameDataProperties.FragmentationMode | 535 |
| Table 638 – MAUType | 535 |
| Table 639 – MAUType with MAUTypeExtension | 539 |
| Table 640 – Valid combinations between MAUType and LinkState | 539 |
| Table 641 – MAUTypeExtensions and its corresponding MAUTypes | 540 |
| Table 642 – CheckSyncMode.CableDelay | 540 |
| Table 643 – CheckSyncMode.SyncMaster | 540 |
| Table 644 – MAUTypeMode.Check | 541 |
| Table 645 – DomainBoundaryIngress | 541 |
| Table 646 – DomainBoundaryEgress | 541 |
| Table 647 – DomainBoundaryAnnounce | 542 |
| Table 648 – MulticastBoundary | 542 |
| Table 649 – PeerToPeerBoundary | 543 |
| Table 650 – DCPBoundary | 543 |
| Table 651 – PreambleLength.Length | 544 |
| Table 652 – LinkState.Link | 544 |
| Table 653 – LinkState.Port | 545 |
| Table 654 – MediaType | 545 |
| Table 655 – MaxBridgeDelay | 545 |
| Table 656 – NumberOfPorts | 546 |
| Table 657 – MaxPortTxDelay | 546 |
| Table 658 – MaxPortRxDelay | 546 |
| Table 659 – MaxLineRxDelay | 546 |
| Table 660 – YellowTime | 547 |
| Table 661 – StartOfRedFrameID in conjunction with ARProperties.StartupMode:= Legacy | 549 |
| Table 662 – StartOfRedFrameID in conjunction with ARProperties.StartupMode:= Advanced | 550 |
| Table 663 – EndOfRedFrameID | 550 |
| Table 664 – Dependencies of StartOfRedFrameID and EndOfRedFrameID | 550 |
| Table 665 – NumberOfAssignments | 550 |
| Table 666 – NumberOfPhases | 551 |
| Table 667 – AssignedValueForReservedBegin | 551 |
| Table 668 – AssignedValueForOrangeBegin | 552 |
| Table 669 – AssignedValueForReservedEnd | 552 |

| | |
|---|-----|
| Table 670 – Values of RedOrangePeriodBegin | 552 |
| Table 671 – Dependencies of RedOrangePeriodBegin, OrangePeriodBegin and GreenPeriodBegin | 553 |
| Table 672 – Values of OrangePeriodBegin with ARProperties.StartupMode == Legacy | 553 |
| Table 673 – Values of OrangePeriodBegin with ARProperties.StartupMode == Advanced | 553 |
| Table 674 – Values of GreenPeriodBegin | 553 |
| Table 675 – EtherType | 554 |
| Table 676 – SyncProperties.Role | 554 |
| Table 677 – SyncProperties.SyncID | 554 |
| Table 678 – ReservedIntervalBegin with ARProperties.StartupMode == Legacy | 555 |
| Table 679 – ReservedIntervalBegin with ARProperties.StartupMode == Advanced | 555 |
| Table 680 – ReservedIntervalEnd with ARProperties.StartupMode == Legacy | 555 |
| Table 681 – ReservedIntervalEnd with ARProperties.StartupMode == Advanced | 555 |
| Table 682 – Dependencies of ReservedIntervalBegin and ReservedIntervalEnd | 555 |
| Table 683 – SyncSendFactor | 556 |
| Table 684 – PTCPTimeoutFactor | 557 |
| Table 685 – PTCPTakeoverTimeoutFactor | 557 |
| Table 686 – PTCPMasterStartupTime | 558 |
| Table 687 – PLLWindow | 558 |
| Table 688 – TimeIObase | 560 |
| Table 689 – TimeDataCycle | 560 |
| Table 690 – TimeIOInput | 560 |
| Table 691 – TimeIOOutput | 561 |
| Table 692 – TimeIOInputValid | 561 |
| Table 693 – TimeIOOutputValid | 561 |
| Table 694 – ControllerApplicationCycleFactor | 561 |
| Table 695 – TimePLLWindow | 562 |
| Table 696 – TimeMasterPriority1 | 563 |
| Table 697 – TimeMasterPriority2 | 563 |
| Table 698 – MRP_Version | 564 |
| Table 699 – MRP_RingState | 564 |
| Table 700 – MRP_DomainUUID | 564 |
| Table 701 – MRP_LengthDomainName | 565 |
| Table 702 – MRP_DomainName | 565 |
| Table 703 – MRP_Role | 565 |
| Table 704 – MRP_Version | 565 |
| Table 705 – MRP_Prio | 566 |
| Table 706 – MRP_TOPchgT | 566 |
| Table 707 – MRP_TOPNRmax | 567 |
| Table 708 – MRP_TSTshortT | 567 |
| Table 709 – MRP_TSTdefaultT | 567 |
| Table 710 – MRP_TSTNRmax | 568 |
| Table 711 – MRP_LNKdownT | 568 |

| | |
|--|-----|
| Table 712 – MRP_LNKupT | 568 |
| Table 713 – MRP_LNKNRmax | 569 |
| Table 714 – MRP_Check.MediaRedundancyManager | 569 |
| Table 715 – MRP_Check.MRP_DomainUUID | 569 |
| Table 716 – MRP_NumberOfEntries | 570 |
| Table 717 – MRP_Instance | 570 |
| Table 718 – MRPIC_LengthDomainName | 570 |
| Table 719 – MRPIC_DomainName | 570 |
| Table 720 – MRPIC_State | 571 |
| Table 721 – MRPIC_Role | 571 |
| Table 722 – MRPIC_DomainID | 571 |
| Table 723 – MRPIC_TOPchgT | 572 |
| Table 724 – MRPIC_TOPNRmax | 572 |
| Table 725 – MRPIC_LinkStatusChangeT | 573 |
| Table 726 – MRPIC_LinkStatusNRmax | 573 |
| Table 727 – MRPIC_LNKdownT | 573 |
| Table 728 – MRPIC_LNKupT | 574 |
| Table 729 – MRPIC_LNKNRmax | 574 |
| Table 730 – MRPIC_StartDelay | 575 |
| Table 731 – MRPIC_Check.MIM | 575 |
| Table 732 – MRPIC_Check.MRPIC_DomainID | 575 |
| Table 733 – VendorBlockType | 576 |
| Table 734 – FiberOpticType | 576 |
| Table 735 – FiberOpticCableType | 576 |
| Table 736 – FiberOpticPowerBudgetType.Value | 577 |
| Table 737 – FiberOpticPowerBudgetType.CheckEnable | 577 |
| Table 738 – NCDropBudgetType.Value | 577 |
| Table 739 – NCDropBudgetType.CheckEnable | 578 |
| Table 740 – CounterStatus.ifInOctets | 579 |
| Table 741 – CounterStatus.ifOutOctets | 579 |
| Table 742 – CounterStatus.ifInDiscards | 579 |
| Table 743 – CounterStatus.ifOutDiscards | 579 |
| Table 744 – CounterStatus.ifInErrors | 579 |
| Table 745 – CounterStatus.ifOutErrors | 580 |
| Table 746 – CounterStatus.Reserved | 580 |
| Table 747 – FSHelloMode.Mode | 581 |
| Table 748 – FSHelloInterval | 581 |
| Table 749 – FSHelloRetry | 582 |
| Table 750 – FSHelloDelay | 582 |
| Table 751 – FSPParameterMode.Mode | 582 |
| Table 752 – FSPParameterUUID | 583 |
| Table 753 – NumberOfSubframeBlocks | 583 |
| Table 754 – SFIOCRProperties.DistributedWatchDogFactor | 583 |

| | |
|--|-----|
| Table 755 – SFIOCRProperties.RestartFactorForDistributedWD | 584 |
| Table 756 – SFIOCRProperties.DFPMODE | 584 |
| Table 757 – SFIOCRProperties.DFPDirection | 585 |
| Table 758 – SFIOCRProperties.DFPRedundantPathLayout..... | 585 |
| Table 759 – SFIOCRProperties.SFCRC16 | 585 |
| Table 760 – SubframeData.Position | 586 |
| Table 761 – SubframeData.DataLength | 586 |
| Table 762 – Event function table..... | 587 |
| Table 763 – SubframeOffset | 587 |
| Table 764 – Event function table..... | 588 |
| Table 765 – SCFEntry..... | 589 |
| Table 766 – ACCommunicationProperties.DFP | 590 |
| Table 767 – ACCommunicationProperties.RTC3 | 590 |
| Table 768 – ACCommunicationProperties.RTCUDP | 590 |
| Table 769 – ACMinDeviceInterval | 591 |
| Table 770 – FromOffsetData..... | 591 |
| Table 771 – NextOffsetData..... | 591 |
| Table 772 – TotalSize | 591 |
| Table 773 – RedundancyInfo.EndPoint1 | 592 |
| Table 774 – RedundancyInfo.EndPoint2 | 592 |
| Table 775 – Valid combination of RedundancyInfo.EndPoint1 and RedundancyInfo.EndPoint2..... | 592 |
| Table 776 – SRProperties.InputValidOnBackupAR with SRProperties.Mode == 0 | 593 |
| Table 777 – SRProperties.InputValidOnBackupAR with SRProperties.Mode == 1 | 594 |
| Table 778 – SRProperties.Reserved_1 | 594 |
| Table 779 – SRProperties.Mode | 594 |
| Table 780 – RedundancyDataHoldFactor | 594 |
| Table 781 – NumberOfEntries..... | 595 |
| Table 782 – PE_OperationalMode | 595 |
| Table 783 – AM_Location.Structure | 596 |
| Table 784 – AM_Location.Levelx | 596 |
| Table 785 – AM_Location.Reserved1..... | 597 |
| Table 786 – AM_Location.BeginSubslotNumber..... | 597 |
| Table 787 – AM_Location.EndSubslotNumber | 597 |
| Table 788 – AM_Location.Reserved2..... | 597 |
| Table 789 – AM_Location.Reserved3..... | 598 |
| Table 790 – AM_Location.Reserved4..... | 598 |
| Table 791 – AM_DeviceIdentification.DeviceSubID | 598 |
| Table 792 – AM_DeviceIdentification.DeviceSubID for AM_DeviceIdentification.Organization:= 0x0000 | 599 |
| Table 793 – AM_DeviceIdentification.DeviceID | 599 |
| Table 794 – AM_DeviceIdentification.VendorID..... | 599 |
| Table 795 – AM_DeviceIdentification.Organization | 599 |
| Table 796 – RS_Properties.AlarmTransport..... | 600 |

| | |
|---|-----|
| Table 797 – RS_BlockType used for events | 600 |
| Table 798 – RS_BlockType used for adjust | 601 |
| Table 799 – RS_BlockLength in conjunction with RS_EventBlock | 601 |
| Table 800 – RS_BlockLength in conjunction with other blocks | 602 |
| Table 801 – RS_Specifier.SequenceNumber | 602 |
| Table 802 – RS_Specifier.Specifier | 602 |
| Table 803 – RS_MinusError | 603 |
| Table 804 – RS_PlusError | 603 |
| Table 805 – RS_ExtensionBlockType | 603 |
| Table 806 – RS_ExtensionBlockLength | 603 |
| Table 807 – RS_MaxScanDelay | 604 |
| Table 808 – RS_AdjustSpecifier.Incident | 604 |
| Table 809 – RS_ReasonCode.Reason | 604 |
| Table 810 – RS_ReasonCode.Detail | 605 |
| Table 811 – RS_DigitalInputCurrentValue.Value | 605 |
| Table 812 – RS_DomainIdentification | 605 |
| Table 813 – RS_MasterIdentification | 605 |
| Table 814 – ActualLocalTimeStamp | 606 |
| Table 815 – LocalTimeStamp | 606 |
| Table 816 – NumberOfLogEntries | 606 |
| Table 817 – EntryDetail | 606 |
| Table 818 – Time_TimeStamp | 607 |
| Table 819 – Allowed combinations of PRAL_Reason, PRAL_ExtReason, and PRAL_ReasonAddValue | 607 |
| Table 820 – PRAL_ChannelProperties.Reserved_1 | 607 |
| Table 821 – PRAL_ChannelProperties.Accumulative | 608 |
| Table 822 – PRAL_ChannelProperties.Reserved_2 | 608 |
| Table 823 – PRAL_ChannelProperties.Direction | 608 |
| Table 824 – Values for PRAL_Reason | 608 |
| Table 825 – Values for PRAL_ExtReason | 610 |
| Table 826 – Usage of PRAL_ReasonAddValue | 610 |
| Table 827 – Values for PRAL_ReasonAddValue[0..3] | 610 |
| Table 828 – Values for PRAL_ReasonAddValue[0] to [127] | 610 |
| Table 829 – ArgsLength check | 611 |
| Table 830 – ARBlockReq – request check | 612 |
| Table 831 – IOCRBlockReq – request check | 613 |
| Table 832 – AlarmCRBlockReq – request check | 617 |
| Table 833 – ExpectedSubmoduleBlockReq – request check | 617 |
| Table 834 – PrmServerBlock – request check | 619 |
| Table 835 – MCRBlockReq – request check | 619 |
| Table 836 – ARRPCBlockReq – request check | 620 |
| Table 837 – IRInfoBlock – request check | 620 |
| Table 838 – SRInfoBlock – request check | 621 |

| | |
|--|-----|
| Table 839 – RSInfoBlock – request check | 621 |
| Table 840 – ArgsLength check | 622 |
| Table 841 – ARBlockRes – response check | 622 |
| Table 842 – IOCRBlockRes – response check | 623 |
| Table 843 – AlarmCRBlockRes – response check | 624 |
| Table 844 – ModuleDiffBlock – response check | 624 |
| Table 845 – ARServerBlockRes – response check | 625 |
| Table 846 – ArgsLength check | 626 |
| Table 847 – ControlBlockConnect(PrmEnd) – request check | 626 |
| Table 848 – ControlBlockPlug(PrmEnd) – request check | 627 |
| Table 849 – ControlBlockConnect(PrmBegin) – request check | 627 |
| Table 850 – SubmoduleListBlock – request check | 628 |
| Table 851 – ArgsLength check | 628 |
| Table 852 – ControlBlockConnect – response check | 629 |
| Table 853 – ControlBlockPlug – response check | 629 |
| Table 854 – ControlBlockConnect(PrmBegin) – response check | 630 |
| Table 855 – ArgsLength check | 631 |
| Table 856 – ControlBlockConnect(AppIRdy) – request check | 631 |
| Table 857 – ControlBlockPlug(AppIRdy) – request check | 632 |
| Table 858 – ArgsLength check | 632 |
| Table 859 – ControlBlockConnect – response check | 633 |
| Table 860 – ControlBlockPlug – response check | 633 |
| Table 861 – ArgsLength check | 634 |
| Table 862 – ReleaseBlock – request check | 635 |
| Table 863 – ArgsLength check | 635 |
| Table 864 – ReleaseBlock – response check | 636 |
| Table 865 – ArgsLength check | 636 |
| Table 866 – IODWriteReqHeader – request check | 637 |
| Table 867 – ArgsLength check | 637 |
| Table 868 – IODWriteResHeader – response check | 638 |
| Table 869 – ArgsLength check | 639 |
| Table 870 – ArgsLength check | 640 |
| Table 871 – ArgsLength check | 640 |
| Table 872 – IODReadReqHeader – request check | 641 |
| Table 873 – RecordDataReadQuery – request check | 642 |
| Table 874 – ArgsLength check | 642 |
| Table 875 – IODReadResHeader – response check | 642 |
| Table 876 – Primitives issued by AP-Context (FAL user) to FSPMDEV | 645 |
| Table 877 – Primitives issued by FSPMDEV to AP-Context (FAL user) | 648 |
| Table 878 – Functions, Macros, Timers and Variables used by the AP-Context (FAL user) to FSPMDEV | 651 |
| Table 879 – Functions, Macros, Timers and Variables used by the FSPMDEV to AP-Context (FAL user) | 652 |
| Table 880 – Primitives issued by AP-Context (FAL user) to FSPMCTL | 655 |

| | |
|--|-----|
| Table 881 – Primitives issued by FSPMCTL to AP-Context (FAL user)..... | 657 |
| Table 882 – Functions, Macros, Timers and Variables used by AP-Context (FAL user) to FSPMCTL..... | 661 |
| Table 883 – Functions, Macros, Timers and Variables used by FSPMCTL to AP-Context (FAL user) | 662 |
| Table 884 – Remote primitives issued or received by ALPMI | 665 |
| Table 885 – Local primitives issued or received by ALPMI | 666 |
| Table 886 – ALPMI state table | 667 |
| Table 887 – Functions, Macros, Timers and Variables used by ALPMI..... | 668 |
| Table 888 – Remote primitives issued or received by ALPMR..... | 669 |
| Table 889 – Local primitives issued or received by ALPMR..... | 670 |
| Table 890 – ALPMR state table..... | 671 |
| Table 891 – Functions, Macros, Timers and Variables used by ALPMR | 673 |
| Table 892 – Remote primitives issued or received by CMDEV | 677 |
| Table 893 – Local primitives issued or received by CMDEV | 679 |
| Table 894 – CMDEV state table | 682 |
| Table 895 – Functions, Macros, Timers and Variables used by CMDEV..... | 684 |
| Table 896 – Remote primitives issued or received by CMDEV_DA..... | 686 |
| Table 897 – Local primitives issued or received by CMDEV_DA | 686 |
| Table 898 – CMDEV_DA state table | 688 |
| Table 899 – Functions, Macros, Timers and Variables used by CMDEV(DA)..... | 688 |
| Table 900 – Remote primitives issued or received by CMSU..... | 689 |
| Table 901 – Local primitives issued or received by CMSU | 689 |
| Table 902 – CMSU state table | 692 |
| Table 903 – Functions, Macros, Timers and Variables used by the CMSU | 695 |
| Table 904 – Remote primitives issued or received by CMIO..... | 695 |
| Table 905 – Local primitives issued or received by CMIO | 695 |
| Table 906 – CMIO state table | 697 |
| Table 907 – Functions used by the CMIO | 698 |
| Table 908 – Remote primitives issued or received by CMRS..... | 698 |
| Table 909 – Local primitives issued or received by CMRS | 699 |
| Table 910 – CMRS state table | 700 |
| Table 911 – Functions, Macros, Timers and Variables used by the CMRS | 700 |
| Table 912 – Remote primitives issued or received by CMWRR | 701 |
| Table 913 – Local primitives issued or received by CMWRR..... | 701 |
| Table 914 – CMWRR state table..... | 703 |
| Table 915 – Functions, Macros, Timers and Variables used by CMWRR..... | 705 |
| Table 916 – Remote primitives issued or received by CMRDR | 706 |
| Table 917 – Local primitives issued or received by CMRDR..... | 706 |
| Table 918 – CMRDR state table..... | 707 |
| Table 919 – Functions, Macros, Timers and Variables used by CMRDR | 708 |
| Table 920 – Remote primitives issued or received by CMSM | 708 |
| Table 921 – Local primitives issued or received by CMSM | 709 |
| Table 922 – CMSM state table | 710 |

| | |
|--|-----|
| Table 923 – Functions, Macros, Timers and Variables used by the CMSM | 711 |
| Table 924 – Remote primitives received by CMPBE | 712 |
| Table 925 – Local primitives issued or received by CMPBE | 712 |
| Table 926 – CMPBE state table | 714 |
| Table 927 – Functions, Macros, Timers and Variables used by the CMPBE | 716 |
| Table 928 – Remote primitives issued or received by CMDMC | 716 |
| Table 929 – Local primitives issued or received by CMDMC | 717 |
| Table 930 – CMDMC state table | 719 |
| Table 931 – Functions, Macros, Timers and Variables used by the CMDMC | 721 |
| Table 932 – Remote primitives issued or received by CMINA | 722 |
| Table 933 – Local primitives issued or received by CMINA | 722 |
| Table 934 – CMINA state table | 724 |
| Table 935 – Functions, Macros, Timers and Variables used by the CMINA | 730 |
| Table 936 – Return values of CheckAPDU | 731 |
| Table 937 – Remote primitives issued or received by CMRPC | 732 |
| Table 938 – Local primitives issued or received by CMRPC | 734 |
| Table 939 – CMRPC state table | 735 |
| Table 940 – Functions, Macros, Timers and Variables used by the CMRPC | 738 |
| Table 941 – Return values of CheckRPC | 740 |
| Table 942 – Remote primitives issued or received by CMSRL | 741 |
| Table 943 – Local primitives issued or received by CMSRL | 742 |
| Table 944 – CMSRL state table | 743 |
| Table 945 – Functions, Macros, Timers and Variables used by the CMSRL | 746 |
| Table 946 – Combinations of DataStatus for Output buffers | 747 |
| Table 947 – Combinations of DataStatus for Input buffers | 747 |
| Table 948 – Remote primitives issued or received by CMSRL_AL | 753 |
| Table 949 – Local primitives issued or received by CMSRL_AL | 753 |
| Table 950 – CMSRL_AL state table | 755 |
| Table 951 – Functions, Macros, Timers and Variables used by the CMSRL_AL | 756 |
| Table 952 – Remote primitives issued or received by CMCTL | 759 |
| Table 953 – Local primitives issued or received by CMCTL | 760 |
| Table 954 – CMCTL state table | 764 |
| Table 955 – Functions, Macros, Timers and Variables used by the CMCTL | 767 |
| Table 956 – Remote primitives issued or received by CTLSM | 767 |
| Table 957 – Local primitives issued or received by CTLSM | 768 |
| Table 958 – CTLSM state table | 769 |
| Table 959 – Functions, Macros, Timers and Variables used by the CTLSM | 770 |
| Table 960 – Remote primitives issued or received by CTLIO | 770 |
| Table 961 – Local primitives issued or received by CTLIO | 771 |
| Table 962 – CTLIO state table | 772 |
| Table 963 – Functions, Macros, Timers and Variables used by the CTLIO | 773 |
| Table 964 – Remote primitives received by CTLRDI | 774 |
| Table 965 – Local primitives issued or received by CTLRDI | 774 |

| | |
|---|-----|
| Table 966 – CTLRDI state table | 776 |
| Table 967 – Functions, Macros, Timers and Variables used by CTLRDI..... | 776 |
| Table 968 – Remote Primitives received by CTLRDR..... | 777 |
| Table 969 – Local primitives issued or received by CTLRDR..... | 778 |
| Table 970 – CTLRDR state table | 778 |
| Table 971 – Functions, Macros, Timers and Variables used by CTLRDR | 779 |
| Table 972 – Remote primitives received by CTLRPC | 779 |
| Table 973 – Local primitives issued or received by CTLRPC..... | 782 |
| Table 974 – CTLRPC state table..... | 783 |
| Table 975 – Functions, Macros, Timers and Variables used by the CTLRPC..... | 785 |
| Table 976 – Remote primitives issued or received by CTLSU | 785 |
| Table 977 – Local Primitives issued or received by CTLSU..... | 786 |
| Table 978 – CTLSU state table | 788 |
| Table 979 – Functions, Macros, Timers and Variables used by the CTLSU | 790 |
| Table 980 – Remote primitives issued or received by CTLWRI..... | 791 |
| Table 981 – Local primitives issued or received by CTLWRI | 791 |
| Table 982 – CTLWRI state table | 793 |
| Table 983 – Functions, Macros, Timers and Variables used by CTLWRI | 794 |
| Table 984 – Remote primitives issued or received by CTLWRR | 795 |
| Table 985 – Local primitives issued or received by CTLWRR..... | 795 |
| Table 986 – CTLWRR state table..... | 797 |
| Table 987 – Functions, Macros, Timers and Variables used by CTLWRR..... | 797 |
| Table 988 – Remote primitives issued or received by CTLPBE | 798 |
| Table 989 – Local primitives issued or received by CTLPBE | 799 |
| Table 990 – CTLPBE state table | 800 |
| Table 991 – Functions, Macros, Timers and Variables used by CTLPBE..... | 802 |
| Table 992 – Remote primitives issued or received by CTLDINA | 803 |
| Table 993 – Local primitives issued or received by CTLDINA..... | 804 |
| Table 994 – CTLDINA state table..... | 806 |
| Table 995 – Functions, Macros, Timers and Variables used by the CTLDINA..... | 809 |
| Table 996 – Remote primitives issued or received by CTLSRL..... | 811 |
| Table 997 – Local primitives issued or received by CTLSRL | 811 |
| Table 998 – CTLSRL state table | 813 |
| Table 999 – Functions, Macros, Timers and Variables used by the CTLSRL | 815 |
| Table A.1 – Examples for the AR establishing..... | 819 |
| Table A.2 – Startup of Alarm transmitter and receiver | 819 |
| Table B.1 – Examples for compatible AR establishing..... | 828 |
| Table I.1 – Priority regeneration and queue usage | 842 |
| Table M.1 – IEEE 802.3 cross reference | 849 |
| Table R.1 – Truth table | 864 |
| Table R.2 – “MAC/PHY configuration/status” with AutoNegotiation disabled..... | 864 |
| Table R.3 – “MAC/PHY configuration/status” with AutoNegotiation enabled | 864 |
| Table R.4 – Auto-negotiation support within “MAC/PHY configuration/status”..... | 864 |

| | |
|---|-----|
| Table R.5 – Auto-negotiation settings | 865 |
| Table T.1 – List of supported MIBs | 867 |
| Table U.1 – Content of archive | 868 |
| Table W.1 – Cross reference IEC 62439-2 “MRP MIB objects” | 887 |
| Table W.2 – Cross reference IEC 62439-2 “Events, created by state machines” | 887 |
| Table W.3 – Cross reference IEC 62439-2 “MRM parameter” | 888 |
| Table W.4 – Cross reference IEC 62439-2 “MRC parameter” | 888 |
| Table W.5 – Cross reference IEC 62439-2 “MRP MIB objects” | 888 |
| Table W.6 – Cross reference IEC 62439-2 “Events, created by state machines” | 889 |
| Table W.7 – Cross reference IEC 62439-2 “MIM parameter” | 889 |
| Table W.8 – Cross reference IEC 62439-2 “MIC parameter” | 889 |
| Table X.1 – Meaning of numbers | 891 |
| Table X.2 – Statistic counters – octets | 892 |
| Table X.3 – Statistic counters – packets or frames | 893 |
| Table X.4 – Statistic counters – errors | 893 |

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
FIELDBUS SPECIFICATIONS –****Part 6-10: Application layer protocol specification –
Type 10 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 IEC 61784-1 and IEC 61784-2.

International Standard IEC 61158-6-10 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This fourth edition cancels and replaces the third edition published in 2014. This edition constitutes a technical revision.

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

- a) integration of system redundancy basic functionality;
- b) integration of dynamic reconfiguration basic functionality;
- c) integration of reporting system basic functionality;
- d) integration of asset management basic functionality; e) integration of media redundancy ring interconnection basic functionality.

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

| | |
|--------------|------------------|
| FDIS | Report on voting |
| 65C/948/FDIS | 65C/956/RVD |

Full information on the voting for the approval of this International 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.

A list of all parts of the IEC 61158 series, published 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 publication will remain unchanged until the stability 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.

IMPORTANT – The 'color inside' logo on the cover page of this publication indicates that it contains colors which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a color printer.

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 standards positioned within the OSI or fieldbus reference models, otherwise incompatible systems may work together in any combination.

NOTE Attention is drawn to the fact that use of the associated protocol type(s) is restricted by its (their) intellectual-property-right holder(s). In all cases, the commitment to limited release of intellectual-property-rights made by the holder(s) 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 protocol type(s) in other combinations may require permission of their respective intellectual-property-right holder(s).

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning Type 10 elements and possibly other types given in this document as follows:

The following patent rights for Type 10 have been announced by [SI]:

| Publication | Title |
|--------------|--|
| WO 02/043336 | System and method for parallel transfer of real-time critical and non-real-time critical data via switchable data networks, particularly Ethernet |
| WO 02/076033 | Synchronous clocked communication system with decentralized input/output modules and methods for integrating decentralized input/output modules in such a system |
| WO 03/028258 | Method for synchronizing nodes of a communication system |
| WO 03/028259 | Communications system and method for synchronizing a communications cycle |
| WO 04/030284 | Method for permanent redundant transmission of data telegrams in communication systems |
| EP 1558002 | Method for assigning an IP address to a device |
| EP 1318630 | Matrices for controlling the device specific data transfer rates on a field bus |

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

The holder of these patent rights has assured the IEC that he/she is willing to negotiate licences either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of these patent rights is registered with IEC. Information may be obtained from:

[SI]: Siemens AG
LC TE IP&IT

Otto-Hahn-Ring 6
D-81739 Munich
Germany

Attention is drawn to the possibility that some of the elements of this document 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.

ISO (www.iso.org/patents) and IEC (http://www.iec.ch/tctools/patent_decl.htm) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the data bases for the most up to date information concerning patents.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-10: Application layer protocol specification – Type 10 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 10 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 International Standard defines in an abstract way the externally visible behavior provided by the Type 10 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.

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

- a) define the wire-representation of the service primitives defined in IEC 61158-5-10 and
- b) define the externally visible behavior associated with their transfer.

This document specifies the protocol of the Type 10 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 61158-5-10.

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.

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.