

INTERNATIONAL STANDARD



**Industrial communication networks – Fieldbus specifications –
Part 4-19: Data-link layer protocol specification – Type 19 elements**



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CONTENTS

FOREWORD.....	24
INTRODUCTION.....	26
1 Scope.....	28
1.1 General.....	28
1.2 Specifications	28
1.3 Procedures	28
1.4 Applicability	28
1.5 Conformance	29
2 Normative references	29
3 Terms, definitions, symbols, acronyms, abbreviations and conventions	29
3.1 Reference model terms and definitions	29
3.2 Additional Type 19 terms and definitions.....	30
3.3 Symbols.....	33
3.4 Acronyms and abbreviations	34
3.5 Additional conventions	35
4 DL-protocol overview.....	35
4.1 Overview	35
4.2 General DLPDU identification	37
4.2.1 Introduction	37
4.2.2 Destination address (Dest MAC).....	37
4.2.3 Source address (Src MAC)	37
4.2.4 EtherType.....	37
4.3 General DLPDU structure	37
4.3.1 Introduction	37
4.3.2 DLPDU header	38
4.3.3 DLPDU payload.....	38
4.4 DLPDU header.....	38
4.4.1 Introduction	38
4.4.2 DLPDU type.....	38
4.5 MDT DLPDU	39
4.5.1 MDT MST field summary	39
4.5.2 Evaluation of MDT header in the slaves.....	39
4.5.3 MDT type.....	40
4.5.4 MDT phase.....	40
4.5.5 MDT CRC.....	40
4.5.6 MDT payload during initialization	40
4.5.7 MDT payload in normal operation (CP4)	44
4.6 AT DLPDU	51
4.6.1 AT header field summary.....	51
4.6.2 Evaluation of AT header in the slaves.....	51
4.6.3 AT type.....	52
4.6.4 AT phase	52
4.6.5 AT CRC	52
4.6.6 AT Payload during initialization.....	52
4.6.7 AT payload in CP4.....	56
4.7 Mechanisms of connections	62
4.7.1 Introduction	62

4.7.2	Configuration of connections	63
4.7.3	Connection control.....	64
4.7.4	Producer state machine	66
4.7.5	Consumer state machine	68
5	DL management	72
5.1	Overview	72
5.2	Initialization of cyclic communication.....	72
5.2.1	Introduction	72
5.2.2	Communication phases (CP)	73
5.2.3	Switching of communication phases (CPS).....	86
5.2.4	Communication Version.....	98
5.2.5	Address allocation in the master and slave	99
5.3	Network topologies	101
5.3.1	Introduction	101
5.3.2	Ring topology	102
5.3.3	Line topology.....	102
5.3.4	Topology conditions of a slave device.....	103
5.3.5	Topology conditions of a multi-slave device	104
5.3.6	Topology state machine.....	108
5.3.7	States of Topology state machine of slave.....	109
5.3.8	Transitions of Topology state machine.....	110
5.4	Redundancy of RT communication with ring topology.....	112
5.4.1	Introduction	112
5.4.2	Sequence with ring break	112
5.4.3	Recovery of ring topology	113
5.4.4	Recovery of P channel.....	114
5.4.5	Recovery of S channel.....	115
5.5	Hot-plug procedure	115
5.5.1	Introduction	115
5.5.2	Hot-plug state machine.....	116
5.5.3	States of HP state machine	117
5.5.4	Transitions of HP state machine	121
5.6	Watchdog	122
5.7	Status procedures.....	122
6	Data transmission methods	123
6.1	Overview	123
6.2	Service channel (SVC).....	123
6.2.1	SVC handling	123
6.2.2	Opening and closing SVC.....	124
6.2.3	Selection of data block element	124
6.2.4	Changing of data block element.....	124
6.2.5	Transmission steps.....	125
6.2.6	SVC valid	126
6.2.7	Handshake bits.....	126
6.2.8	Read/Write	127
6.2.9	Busy bit	127
6.2.10	Service channel initialization	128
6.2.11	Reaction to SVC handshake timeout.....	128
6.2.12	Reaction to error messages in the service channel	128

6.2.13	Service channel error messages	128
6.2.14	Procedure command functions via the service channel	131
6.3	RT Channel	137
6.3.1	Introduction	137
6.3.2	Read_Cyclic (RDC)	137
6.3.3	Write_Cyclic (WRC).....	137
6.3.4	Notify_Cyclic_Data (NCD)	137
6.4	Transmission and activation of Type 19 time.....	137
6.5	Multiplexing of real-time data with data containers	139
6.5.1	General	139
6.5.2	Functionality of standard data container	141
6.5.3	Functionality of extended data container (preferred function).....	145
6.5.4	Data container diagnostic	150
6.6	Handling of Real-time bits	150
6.6.1	General	150
6.6.2	Real-time bits (RTB).....	151
6.6.3	RTB word container	152
6.6.4	RTB list container	152
6.7	SMP.....	153
6.7.1	Definitions	153
6.7.2	Structure of the Session Control Header (SCH)	154
6.7.3	Evaluation sequence of session control header by the consumer.....	156
6.7.4	Multiplexing of two sessions (example).....	157
6.7.5	Priorization	157
6.7.6	Diagnosis of SMP	158
6.7.7	Definition of SMP containers.....	158
6.7.8	Example	158
6.8	Oversampling.....	159
6.8.1	Description	159
6.8.2	General	159
6.8.3	Constraints	159
6.8.4	Oversampling Input	159
6.8.5	Oversampling Output.....	160
6.8.6	Oversampling Identification	160
6.8.7	Oversampling Configuration.....	161
6.8.8	Application example	161
6.8.9	Oversampling State Machine	161
7	Telegram timing and DLPDU handling	163
7.1	Communication mechanisms.....	163
7.1.1	Cycle time	163
7.1.2	Medium access.....	166
7.1.3	Calculation of the Type 19 telegram length	168
7.1.4	Timing calculation of RT channel	168
7.1.5	Calculation of S-0-1006 AT0 transmission starting time (t1).....	169
7.1.6	Timing calculation of UC channel.....	170
7.1.7	Telegram timing in CP0	171
7.1.8	Telegram timing in CP1 and CP2	172
7.1.9	Telegram timing in CP3 and CP4	174
7.1.10	Unified communication mechanisms	175

7.1.11	Internet Protocol Services (IPS).....	187
7.2	Synchronization	224
7.2.1	Network synchronization.....	224
7.2.2	Synchronization of producer cycles.....	232
7.3	Processing methods of connection data	233
7.3.1	General	233
7.3.2	Synchronous processing of application data in the slave	234
7.3.3	Cyclic processing of application data in the slave	235
7.3.4	Non-synchronous processing of application data in the slave	236
8	Communication Error handling and monitoring.....	236
8.1	Invalid telegrams	236
8.2	Response to MDT and AT telegram failure.....	237
8.3	Error counters in the slave.....	237
8.3.1	Error effects on communication phases	237
8.4	Status codes of Type 19 communication profile (SCP)	238
8.5	Priority of diagnosis classes.....	240
Annex A (normative)	IDN – Identification numbers	242
A.1	IDN specification.....	242
A.1.1	Introduction	242
A.1.2	Element 1: structure of IDN	242
A.1.3	Element 2: structure of name.....	243
A.1.4	Element 3: structure of attribute.....	244
A.1.5	Element 4: structure of unit.....	246
A.1.6	Element 5: structure of minimum value	247
A.1.7	Element 6: structure of maximum value	247
A.1.8	Element 7: structure of operation data	247
A.1.9	Structure of Data status.....	249
A.2	Identification numbers in numerical orders	250
A.3	Detailed specification of communication-related IDNs	254
A.3.1	IDN S-0-0014 Interface status	254
A.3.2	IDN S-0-0021 IDN-list of invalid operation data for CP2.....	255
A.3.3	IDN S-0-0022 IDN-list of invalid operation data for CP3.....	256
A.3.4	IDN S-0-0026 IDN allocation of producer RTB word container	257
A.3.5	IDN S-0-0027 IDN allocation of consumer RTB word container	257
A.3.6	IDN S-0-0127 CP3 transition check	258
A.3.7	IDN S-0-0128 CP4 transition check	259
A.3.8	IDN S-0-0144 Producer RTB word container.....	260
A.3.9	IDN S-0-0145 Consumer RTB word container	260
A.3.10	IDN S-0-0187 IDN-list of configurable data as producer.....	261
A.3.11	IDN S-0-0188 IDN-list of configurable data as consumer	261
A.3.12	IDN S-0-0328 Bit allocation of producer RTB word container	262
A.3.13	IDN S-0-0329 Bit allocation of consumer RTB word container.....	263
A.3.14	IDN S-0-0360 MDT data container A1.....	263
A.3.15	IDN S-0-0361 MDT data container B1.....	264
A.3.16	IDN S-0-0362 MDT data container A list index.....	265
A.3.17	IDN S-0-0363 MDT data container B list index.....	266
A.3.18	IDN S-0-0364 AT data container A1.....	267
A.3.19	IDN S-0-0365 AT data container B1.....	268
A.3.20	IDN S-0-0366 AT data container A list index.....	269

A.3.21	IDN S-0-0367 AT data container B list index	270
A.3.22	IDN S-0-0368 Data container A pointer	271
A.3.23	IDN S-0-0369 Data container B pointer	273
A.3.24	IDN S-0-0370 MDT data container A/B configuration list	274
A.3.25	IDN S-0-0371 AT data container A/B configuration list	275
A.3.26	IDN S-0-0394 List IDN	275
A.3.27	IDN S-0-0395 List index	276
A.3.28	IDN S-0-0396 Number of list elements	277
A.3.29	IDN S-0-0397 List segment	277
A.3.30	IDN S-0-0398 IDN list of configurable real-time bits as producer	278
A.3.31	IDN S-0-0399 IDN list of configurable real-time bits as consumer	279
A.3.32	IDN S-0-0444 IDN-list of configurable data in the AT data container	280
A.3.33	IDN S-0-0445 IDN-list of configurable data in the MDT data container	280
A.3.34	IDN S-0-0450 MDT data container A2	281
A.3.35	IDN S-0-0451 MDT data container A3	282
A.3.36	IDN S-0-0452 MDT data container A4	283
A.3.37	IDN S-0-0453 MDT data container A5	284
A.3.38	IDN S-0-0454 MDT data container A6	285
A.3.39	IDN S-0-0455 MDT data container A7	286
A.3.40	IDN S-0-0456 MDT data container A8	287
A.3.41	IDN S-0-0457 MDT data container A9	288
A.3.42	IDN S-0-0458 MDT data container A10	289
A.3.43	IDN S-0-0459 MDT data container B2	289
A.3.44	IDN S-0-0480 AT data container A2	290
A.3.45	IDN S-0-0481 AT data container A3	291
A.3.46	IDN S-0-0482 AT data container A4	292
A.3.47	IDN S-0-0483 AT data container A5	293
A.3.48	IDN S-0-0484 AT data container A6	294
A.3.49	IDN S-0-0485 AT data container A7	295
A.3.50	IDN S-0-0486 AT data container A8	296
A.3.51	IDN S-0-0487 AT data container A9	297
A.3.52	IDN S-0-0488 AT data container A10	298
A.3.53	IDN S-0-0489 AT data container B2	299
A.3.54	IDN S-0-0490 MDT data container A2 configuration list	300
A.3.55	IDN S-0-0491 MDT data container A3 configuration list	301
A.3.56	IDN S-0-0492 MDT data container A4 configuration list	302
A.3.57	IDN S-0-0493 MDT data container A5 configuration list	302
A.3.58	IDN S-0-0494 MDT data container A6 configuration list	303
A.3.59	IDN S-0-0495 MDT data container A7 configuration list	304
A.3.60	IDN S-0-0496 MDT data container A8 configuration list	304
A.3.61	IDN S-0-0497 MDT data container A9 configuration list	305
A.3.62	IDN S-0-0498 MDT data container A10 configuration list	306
A.3.63	IDN S-0-0500 AT data container A2 configuration list	306
A.3.64	IDN S-0-0501 AT data container A3 configuration list	307
A.3.65	IDN S-0-0502 AT data container A4 configuration list	308
A.3.66	IDN S-0-0503 AT data container A5 configuration list	308
A.3.67	IDN S-0-0504 AT data container A6 configuration list	309
A.3.68	IDN S-0-0505 AT data container A7 configuration list	310
A.3.69	IDN S-0-0506 AT data container A8 configuration list	310

A.3.70	IDN S-0-0507 AT data container A9 configuration list	311
A.3.71	IDN S-0-0508 AT data container A10 configuration list	312
A.3.72	IDN S-0-1000.0.0 List of SCP Classes & Version	312
A.3.73	IDN S-0-1000.0.1 Active SCP Classes	316
A.3.74	IDN S-0-1000.0.2 Communication compatible functions	316
A.3.75	IDN S-0-1002 Communication cycle time	317
A.3.76	IDN S-0-1003 Allowed MST losses in CP3/CP4	318
A.3.77	IDN S-0-1005 Minimum feedback processing time (t_5)	319
A.3.78	IDN S-0-1006 AT transmission starting time (t_1)	320
A.3.79	IDN S-0-1007 Synchronization time (Tsync)	320
A.3.80	IDN S-0-1008 Command value valid time (t_3)	322
A.3.81	IDN S-0-1009 Device Control (C-DEV) offset in MDT	322
A.3.82	IDN S-0-1010 Lengths of MDTs	323
A.3.83	IDN S-0-1011 Device Status (S-DEV) offset in AT	324
A.3.84	IDN S-0-1012 Lengths of ATs	325
A.3.85	IDN S-0-1013 SVC offset in MDT	327
A.3.86	IDN S-0-1014 SVC offset in AT	327
A.3.87	IDN S-0-1015 Ring delay	328
A.3.88	IDN S-0-1016 Slave delay (P/S)	329
A.3.89	IDN S-0-1017 UC channel transmission time	330
A.3.90	IDN S-0-1019 MAC address	331
A.3.91	IDN S-0-1020.0.1 Current IP address	331
A.3.92	IDN S-0-1020 IP address	332
A.3.93	IDN S-0-1021.0.1 Current subnet mask	333
A.3.94	IDN S-0-1021 Subnet mask	333
A.3.95	IDN S-0-1022.0.1 Current gateway address	334
A.3.96	IDN S-0-1022 Gateway address	335
A.3.97	IDN S-0-1023 SYNC jitter	336
A.3.98	IDN S-0-1024 SYNC delay measuring procedure command	337
A.3.99	IDN S-0-1026 Version of communication hardware	338
A.3.100	IDN S-0-1027.0.1 Requested MTU	339
A.3.101	IDN S-0-1027.0.2 Effective MTU	340
A.3.102	IDN S-0-1028 Error counter MST-P/S	341
A.3.103	IDN S-0-1031 Test pin assignment Port 1 & Port 2	342
A.3.104	IDN S-0-1032 Communication control	343
A.3.105	IDN S-0-1034 PHY error counter Port 1 & Port 2	344
A.3.106	IDN S-0-1035.0.01 Error counter P&S	345
A.3.107	IDN S-0-1035.0.0 Error counter Port 1 & Port 2	346
A.3.108	IDN S-0-1036 Inter Frame Gap	348
A.3.109	IDN S-0-1037 Slave jitter	349
A.3.110	IDN S-0-1039.0.1 Current active hostname	350
A.3.111	IDN S-0-1039 Hostname	350
A.3.112	IDN S-0-1040 Sub-device address	351
A.3.113	IDN S-0-1041 AT Command value valid time (t_9)	352
A.3.114	IDN S-0-1042 Topology index	353
A.3.115	IDN S-0-1044 Device Control (C-DEV)	354
A.3.116	IDN S-0-1045 Device Status	356
A.3.117	IDN S-0-1046 List of device addresses in device	358
A.3.118	IDN S-0-1047 Maximum Consumer Activation Time (t_{11})	359

A.3.119	IDN S-0-1048 Activate network settings.....	360
A.3.120	IDN S-0-1050.x.01 Connection setup.....	360
A.3.121	IDN S-0-1050.x.02 Connection Number.....	362
A.3.122	IDN S-0-1050.x.03 Telegram assignment.....	363
A.3.123	IDN S-0-1050.x.04 Max. Length of Connection.....	364
A.3.124	IDN S-0-1050.x.05 Current length of connection.....	365
A.3.125	IDN S-0-1050.x.06 Configuration List.....	365
A.3.126	IDN S-0-1050.x.07 Assigned connection capability.....	366
A.3.127	IDN S-0-1050.x.08 Connection Control.....	367
A.3.128	IDN S-0-1050.x.09 Connection state.....	367
A.3.129	IDN S-0-1050.x.10 Producer cycle time.....	368
A.3.130	IDN S-0-1050.x.11 Allowed Data Losses.....	369
A.3.131	IDN S-0-1050.x.12 Error Counter Data Losses.....	369
A.3.132	IDN S-0-1050.x.20 IDN Allocation of real-time bit.....	370
A.3.133	IDN S-0-1050.x.21 IDN Allocation of real-time bit.....	370
A.3.134	IDN S-0-1051 Image of connection setups.....	371
A.3.135	IDN S-0-1060.x.01 Default configuration.....	372
A.3.136	IDN S-0-1060.x.02 Configuration mask.....	372
A.3.137	IDN S-0-1060.x.03 Maximum quantity of this connection capability.....	373
A.3.138	IDN S-0-1060.x.04 Max. connection length of connection capability.....	373
A.3.139	IDN S-0-1060.x.06 Configurable IDNs of connection capability.....	374
A.3.140	IDN S-0-1060.x.07 Maximum processing time.....	375
A.3.141	IDN S-0-1060.x.10 Minimum producer cycle time.....	376
A.3.142	IDN S-0-1061 Maximum TSref-Counter.....	376
A.3.143	IDN S-0-1080.x.02 Producer RTB list container.....	377
A.3.144	IDN S-0-1080.x.03 IDN allocation of producer RTB list container.....	377
A.3.145	IDN S-0-1080.x.04 Bit allocation of producer RTB list container.....	378
A.3.146	IDN S-0-1081.x.02 Consumer RTB list container.....	379
A.3.147	IDN S-0-1081.x.03 IDN allocation of consumer RTB list container.....	379
A.3.148	IDN S-0-1081.x.04 Bit allocation of consumer RTB list container.....	380
A.3.149	IDN S-0-1099.0.1 Test-IDN Control for SCP Conformity Purpose.....	381
A.3.150	IDN S-0-1099.0.2 Test-IDN Container for SCP Conformity purpose.....	382
A.3.151	IDN S-0-1100.0.01 Diagnostic counter sent SMP fragments.....	382
A.3.152	IDN S-0-1100.0.02 Diagnostic counter received SMP fragments.....	383
A.3.153	IDN S-0-1100.0.03 Diagnostic counter discarded SMP fragments.....	383
A.3.154	IDN S-0-1101.x.01 SMP Container Data.....	384
A.3.155	IDN S-0-1101.x.02 List of session identifiers.....	385
A.3.156	IDN S-0-1101.x.03 List of session priorities.....	385
A.3.157	IDN S-0-1150.x.01 OVS Control (C-OVS).....	386
A.3.158	IDN S-0-1150.x.02 OVS Status (S-OVS).....	387
A.3.159	IDN S-0-1150.x.03 OVS Container.....	388
A.3.160	IDN S-0-1150.x.04 Sample time.....	389
A.3.161	IDN S-0-1150.x.05 Phase shift.....	390
A.3.162	IDN S-0-1150.x.06 Configuration List OVS – IDNs.....	390
A.3.163	IDN S-0-1150.x.07 Configuration List OVS – Offset.....	391
A.3.164	IDN S-0-1150.x.08 Configuration List OVS – Length.....	392
A.3.165	IDN S-0-1150.x.09 Assigned Oversampling Capability.....	392
A.3.166	IDN S-0-1150.x.10 Number of Samples.....	393
A.3.167	IDN S-0-1151.x.01 Maximum number of samples.....	394

A.3.168	IDN S-0-1151.x.02 Internal resolution	394
A.3.169	IDN S-0-1151.x.03 Maximum quantity of this oversampling capability	395
A.3.170	IDN S-0-1151.x.04 Minimum sample time	396
A.3.171	IDN S-0-1151.x.06 Configurable IDNs of OVS capability	396
A.3.172	IDN S-0-1151.x.07 Configurable IDNs of OVS Capability – Offset	397
A.3.173	IDN S-0-1151.x.08 Configurable IDNs of OVS Capability – Length	397
A.3.174	IDN S-0-1152 Amount of OVS Domains	398
Annex B	(normative) SCP– Classification	399
B.1	General concept of profiling	399
B.2	Function Groups related to the SCP	400
B.2.1	FG SCP Identification	400
B.2.2	FG Timing	400
B.2.3	FG Telegram Setup	400
B.2.4	FG Control	401
B.2.5	FG Bus-Diagnosis	401
B.2.6	FG Connection	401
B.2.7	FG NRT	402
B.2.8	FG MUX	402
B.2.9	FG SMP	403
B.2.10	FG RTB	404
B.3	Type 19 communication classes	404
B.3.1	General	404
B.3.2	SCP_FixCFG	404
B.3.3	SCP_FixCFG_0x02	406
B.3.4	SCP_FixCFG_0x03	406
B.3.5	SCP_VarCFG	406
B.3.6	SCP_VarCFG_0x02	407
B.3.7	SCP_VarCFG_0x03	408
B.3.8	SCP_Sync	408
B.3.9	SCP_Sync	408
B.3.10	SCP_Sync_0x02	409
B.3.11	SCP_Sync_0x03	409
B.3.12	SCP_WD	409
B.3.13	SCP_WD_0x02	409
B.3.14	SCP_Diag	410
B.3.15	SCP_RTB	410
B.3.16	SCP_HP	410
B.3.17	SCP_SMP	410
B.3.18	SCP_Mux	411
B.3.19	SCP_Ext_Mux	411
B.3.20	SCP_NRT	411
B.3.21	SCP_Sig	412
B.3.22	SCP_ListSeg	412
B.3.23	SCP_IPS	412
B.3.24	SCP_Cap	412
B.3.25	SCP_RTBListProd	413
B.3.26	SCP_RTBListCons	413
B.3.27	SCP_SysTime	413
B.3.28	SCP_RTBWordProd	413

B.3.29	SCP_RTbWordCons.....	413
B.3.30	SCP_SafetyCon.....	414
B.3.31	SCP_OvS_Basic.....	414
B.3.32	SCP_NRTPC.....	415
B.3.33	SCP_Cyc.....	415
Annex C (normative)	GDP (Generic Device Profile)	416
C.1	General.....	416
C.2	Function Groups	416
C.2.1	Function Group Diagnosis	416
C.2.2	Function Group Archiving	418
C.2.3	Function Group Administration.....	418
C.2.4	Function Group Identification.....	418
C.2.5	Function Group State machine.....	419
C.2.6	Function Group Time	423
C.2.7	Function Group Conformance Test GDP	424
C.3	Classification	424
C.3.1	General	424
C.3.2	GDP_Basic.....	424
C.3.3	GDP_DiagT	424
C.3.4	GDP_DiagTAdv	425
C.3.5	GDP_LNg	425
C.3.6	GDP_PWD	425
C.3.7	GDP_Id	425
C.3.8	GDP_Rev	425
C.3.9	GDP_QA	426
C.3.10	GDP_CKs.....	426
C.3.11	GDP_CKsUser.....	426
C.3.12	GDP_StM	426
C.3.13	GDP_BKP.....	426
C.3.14	GDP_BKPAdv.....	427
C.3.15	GDP_RST.....	427
C.3.16	GDP_CIPSafetyDev.....	427
C.4	List of all GDP related IDNs	427
C.4.1	IDN specification	427
C.4.2	Identification numbers in numerical orders.....	427
C.4.3	Detailed specification of communication-related IDNs.....	429
C.5	GDP status codes	475
Bibliography	477
Figure 1	– Example of offsets within MDT payload	45
Figure 2	– Example of Offsets within AT payload	57
Figure 3	– Flow of application data	63
Figure 4	– Telegram assignment and connection length.....	64
Figure 5	– Connection control state machine producer.....	66
Figure 6	– Connection control state machine consumer	69
Figure 7	– Communication phase (CP) state machine	74
Figure 8	– Sub-state machine of CP0.....	75

Figure 9 – Sub-state machine of CP1.....	79
Figure 10 – CPSwitch state machine master	88
Figure 11 – CPSwitch state machine of the slave.....	93
Figure 12 – Address allocation with line.....	100
Figure 13 – Address allocation with ring.....	100
Figure 14 – Address allocation with interrupted ring.....	101
Figure 15 – Ring topology with P and S channel	102
Figure 16 – Line topology with P channel (as example).....	103
Figure 17 – Block diagram of a slave	103
Figure 18 – Topology states of a slave.....	104
Figure 19 – Addressing of multi-slave device	105
Figure 20 – Multi-slave device in ring topology or not last in line topology.....	106
Figure 21 – Multi-slave device as last in line topology.....	106
Figure 22 – Multi-slave device in line (left).....	108
Figure 23 – Multi-slave device in line (right).....	108
Figure 24 – Multi-slave device in ring.....	108
Figure 25 – Topology state machine of a slave	109
Figure 26 – Ring without break	112
Figure 27 – Ring break	113
Figure 28 – Ring break on master	113
Figure 29 – Recovery of P channel (1).....	114
Figure 30 – Recovery of P channel (2).....	114
Figure 31 – Recovery of S channel (1).....	115
Figure 32 – Recovery of S channel (2).....	115
Figure 33 – Communication phase and hot-plug state machine.....	117
Figure 34 – Service channel handling diagram.....	124
Figure 35 – Communication step proceeding diagram.....	125
Figure 36 – State machine for procedure command execution	134
Figure 37 – Interaction of procedure command control and acknowledgement	135
Figure 38 – Procedure command execution without interrupt	136
Figure 39 – Procedure command execution with interrupt	136
Figure 40 – Procedure command execution with error message.....	137
Figure 41 – Type 19 Time Transmission	139
Figure 42 – Data container configuration without acknowledge (slave).....	143
Figure 43 – Data container configuration with acknowledge (slave).....	144
Figure 44 – Processing of list index in the MDT data.....	145
Figure 45 – Structure of extended data container.....	148
Figure 46 – Transport container.....	154
Figure 47 – UML Sequence Diagram: Multiplexing of two sessions (Example)	157
Figure 48 – Oversampling overview	159
Figure 49 – Oversampling timing input (producer).....	160
Figure 50 – Oversampling timing output (consumer)	160
Figure 51 – Oversampling state machine	162

Figure 52 – Synchronized cascaded networks.....	164
Figure 53 – Diagram of phase locked loop	165
Figure 54 – Synchronization process	166
Figure 55 – Telegram timing reference.....	167
Figure 56 – Calculation of telegram length.....	168
Figure 57 – Calculation of t1	169
Figure 58 – Determination of UC channel.....	171
Figure 59 – Timing diagram of CP0.....	171
Figure 60 – Timing diagram of CP1 and CP2 with 2 MDT, 2AT and UC channel.....	172
Figure 61 – Timing diagram of CP1 and CP2 with 4 MDT, 4 AT and UC channel.....	173
Figure 62 – Timing diagram of CP1 and CP2 with 2 MDT, UC channel and 2 AT.....	173
Figure 63 – Timing diagram of CP1 and CP2 with 4 MDT, UC channel and 4 AT.....	174
Figure 64 – Telegram sequence.....	175
Figure 65 – Time delay of store and forward	176
Figure 66 – Time delay of cut through.....	177
Figure 67 – The two defined positions of the UC channel.....	178
Figure 68 – First and last transmit during UC channel.....	179
Figure 69 – UC telegram with payload	180
Figure 70 – Activated and deactivated collision buffer.....	183
Figure 71 – Double line without slave in between.....	184
Figure 72 – Double line with one slave in between.....	185
Figure 73 – Double line with several slaves in between.....	186
Figure 74 – S/IP busy response	191
Figure 75 – Client connection	192
Figure 76 – Server connection	193
Figure 77 – S/IP asynchronous request	194
Figure 78 – S/IP PDU	194
Figure 79 – S/IP error response	196
Figure 80 – UDP Browsing.....	201
Figure 81 – Sequence of setting a new network configuration on one device using UDP....	204
Figure 82 – UDP Identification	209
Figure 83 – Usage UDP reset request.....	221
Figure 84 – Sequence for watchdog trigger service and client application timeout.....	222
Figure 85 – Synchronization timing	225
Figure 86 – Synchronization trigger	225
Figure 87 – Timing of TSref with ring and line.....	227
Figure 88 – Timing of TSref with interrupted ring	229
Figure 89 – Determination of the SYNC delay time	230
Figure 90 – Definition of TSref.....	231
Figure 91 – Timing with different cycle times	233
Figure 92 – Timing with the same cycle times.....	233
Figure 93 – Synchronous application data processing.....	235
Figure 94 – Cyclic application data processing.....	236

Figure 95 – Non-synchronous application data processing	236
Figure A.1 – IDN name structure	244
Figure A.2 – Unit structure	246
Figure A.3 – Structure of IDN operation data with variable length	248
Figure A.4 – Example of synchronization timing with different producer cycles.....	321
Figure A.5 – Definition of MDT length	324
Figure A.6 – Lengths of MDTs (example)	324
Figure A.7 – Definition of AT length	326
Figure A.8 – Lengths of ATs (example)	326
Figure A.9 – Structure of MAC address	331
Figure A.10 – Structure of IP address	333
Figure A.11 – Structure of subnet mask	334
Figure A.12 – Structure of gateway address.....	336
Figure A.13 – Structure of List of Sub-device addresses	359
Figure A.14 – Definition of connection length	365
Figure A.15 – Synchronization with ring	375
Figure A.16 – Configuration example	389
Figure B.1 – Technical Profiling in Type 19.....	399
Figure C.1 – State machine without class GDP_StM	420
Figure C.2 – State machine without class GDP_StM	422
Figure C.3 – Password State Machine	437
Figure C.4 – Structure of Date information	457
Figure C.5 – Structure of QA date information.....	458
Figure C.6 – Structure of Service date information	459
Figure C.7 – Structure of Calibration date information.....	460
Figure C.8 – Structure of Calibration due date information	461
Figure C.9 – Mapping of data into the InputData and OutputData container	465
Table 1 – Ethernet DLPDU identification	37
Table 2 – Data structure in a DLPDU	37
Table 3 – DLPDU payload header	38
Table 4 – DLPDU type	39
Table 5 – MDT header	39
Table 6 – MDT header to be considered by the slave.....	39
Table 7 – MDT phase.....	40
Table 8 – MDT0 structure in CP0	41
Table 9 – Communication version	41
Table 10 – MDT0 in CP1 and CP2 (topology indices 0 to 127)	42
Table 11 – MDT1 in CP1 and CP2 (topology indices 128 to 255)	43
Table 12 – MDT2 in CP1 and CP2 (topology indices 256 to 383)	43
Table 13 – MDT3 in CP1 and CP2 (topology indices 384 to 511)	44
Table 14 – MDT data field.....	45
Table 15 – MDT hot-plug field.....	46

Table 16 – HP address in MDT-HP field.....	46
Table 17 – HP control field (in HP0 and HP1)	47
Table 18 – Extended Function Field	48
Table 19 – MDT SVC (for each slave).....	49
Table 20 – SVC control word (DLL).....	49
Table 21 – MDT device control	50
Table 22 – MDT application data.....	50
Table 23 – Device control field (C-DEV).....	51
Table 24 – AT MST header	51
Table 25 – AT header fields to be considered by the slave.....	52
Table 26 – AT0 structure in CP0	53
Table 27 – Topology index in AT0-CP0	53
Table 28 – AT0 in CP1 and CP2 (topology indices 0 to 127)	54
Table 29 – AT1 in CP1 and CP2 (topology indices 128 to 255)	54
Table 30 – AT2 in CP1 and CP2 (topology indices 256 to 383)	55
Table 31 – AT3 in CP1 and CP2 (topology indices 384 to 511)	55
Table 32 – AT data field.....	56
Table 33 – AT hot-plug field in HP0 and HP1	57
Table 34 – HP address in AT-HP field.....	58
Table 35 – HP status field (in HP0 and HP1).....	58
Table 36 – AT SVC (for each slave).....	59
Table 37 – AT SVC status description (DLL)	59
Table 38 – AT device status.....	60
Table 39 – AT connection data	60
Table 40 – Device status field	61
Table 41 – Structure of the connection.....	64
Table 42 – Connection control (C-CON).....	65
Table 43 – Connection control combinations	67
Table 44 – States of the producer state machine	67
Table 45 – States of the producer sub-state machine.....	67
Table 46 – Producer transitions	68
Table 47 – States of the consumer state machine	70
Table 48 – States of the consumer sub-state machine	70
Table 49 – Consumer transitions.....	71
Table 50 – States of master CP0 sub-state machine	76
Table 51 – Transitions of master CP0 sub-state machine.....	76
Table 52 – States of slave CP0 sub-state machine	77
Table 53 – Transitions of slave CP0 sub-state machine	77
Table 54 – States of master CP1 sub-state machine	79
Table 55 – Transitions of master CP1 sub-state machine.....	80
Table 56 – States of slave CP1 sub-state machine	80
Table 57 – Transitions of slave CP1 sub-state machine	81
Table 58 – MDT hot-plug field in CP3 and after ring recovery	83

Table 59 – Transitions of CP state machine	85
Table 60 – States of master CPSwitch state machine	89
Table 61 – Transitions of master CPSwitch state machine	90
Table 62 – States of slave CPSwitch state machine	94
Table 63 – Transitions of slave CPSwitch state machine	95
Table 64 – Transitions of slave CPSwitch state machine (transitions with warning)	95
Table 65 – Transitions of slave CPSwitch state machine (transitions with error)	96
Table 66 – Diagnostics of CPS state machine slave	97
Table 67 – Determination of the topology indices (1)	106
Table 68 – Determination of the topology indices (2)	106
Table 69 – Determination of the topology indices (3)	107
Table 70 – Topology status of multi-slave device	107
Table 71 – Topology settings of multi-slave device	107
Table 72 – States of Topology state machine of slave	109
Table 73 – Transitions of Topology state machine	111
Table 74 – Transitions of Topology state machine (transitions with warning)	111
Table 75 – Transitions of Topology state machine (transitions with error)	112
Table 76 – MDT hot-plug field in HP0	119
Table 77 – MDT hot-plug field in HP1	120
Table 78 – AT hot-plug field in HP1	120
Table 79 – Transitions of HP state machine	121
Table 80 – AT hot-plug field in HP1 (error)	122
Table 81 – Condition for modifying data block elements	125
Table 82 – List of data block element and step numbers	126
Table 83 – SVC channel evaluation	127
Table 84 – Reaction to handshake timeout	128
Table 85 – Reaction to error message	128
Table 86 – Error messages	129
Table 87 – Structure of Procedure command control	132
Table 88 – Procedure command acknowledgment (data status)	132
Table 89 – List of valid standard data container combinations	142
Table 90 – Example of IDN and bit allocation of RTB container	153
Table 91 – Structure of the Session Control Header	155
Table 92 – Lists in S-0-1101.7.x	158
Table 93 – States of the oversampling state machine	162
Table 94 – Transitions of the oversampling state machine	163
Table 95 – Summary of Jitter in a Type 19 network	165
Table 96 – Parameter for timing calculation	167
Table 97 – Default values of CP1/2 (case 1)	172
Table 98 – Default values of CP1/2 (case 2)	173
Table 99 – Structure of port/MAC table	182
Table 100 – Insertion of entry	182
Table 101 – Update of entries	183

Table 102 – Slave collision buffer	184
Table 103 – Physical topology Master (CP0).....	186
Table 104 – Collision buffer of Master.....	187
Table 105 – Definition of data types	188
Table 106 – Overview on IP-based protocols	189
Table 107 – Message Types	195
Table 108 – User-specific Message Types	196
Table 109 – Common error codes	198
Table 110 – Nameplate IDs.....	210
Table 111 – IPS classes	223
Table 112 – Class TCP Basic	224
Table 113 – Class UDP Basic	224
Table 114 – Class Device Management	224
Table 115 – Explore & IP Configuration Services	224
Table 116 – Class Type 19 Parameter Access	224
Table 117 – SCP specific status codes	238
Table 118 – Overview on diagnosis classes	241
Table A.1 – Data block structure	242
Table A.2 – Parameter structure	243
Table A.3 – Element 3 of IDNs.....	245
Table A.4 – Valid combinations of the display formats	246
Table A.5 – Example of the structure of an IDN-list.....	249
Table A.6 – Data status structure.....	250
Table A.7 – List of relevant communication-related IDNs	250
Table A.8 – Attributes for IDN S-0-0014	254
Table A.9 – Structure of interface status	255
Table A.10 – Attributes for IDN S-0-0021	256
Table A.11 – Attributes for IDN S-0-0022	256
Table A.12 – Attributes for IDN S-0-0026	257
Table A.13 – Attributes for IDN S-0-0027	258
Table A.14 – Attributes for IDN S-0-0127	258
Table A.15 – Attributes for IDN S-0-0128	259
Table A.16 – Attributes for IDN S-0-0144	260
Table A.17 – Attributes for IDN S-0-0027	260
Table A.18 – Attributes for IDN S-0-0187	261
Table A.19 – Attributes for IDN S-0-0188	262
Table A.20 – Attributes for IDN S-0-0328	262
Table A.21 – Attributes for IDN S-0-0329	263
Table A.22 – Attributes for IDN S-0-0360	264
Table A.23 – Attributes for IDN S-0-0361	265
Table A.24 – Attributes for IDN S-0-0362	266
Table A.25 – List index of MDT data container A.....	266
Table A.26 – Attributes for IDN S-0-0363	267

Table A.27 – List index of MDT data container B.....	267
Table A.28 – Attributes for IDN S-0-0364.....	268
Table A.29 – Attributes for IDN S-0-0365.....	269
Table A.30 – Attributes for IDN S-0-0366.....	270
Table A.31 – List index of AT data container A.....	270
Table A.32 – Attributes for IDN S-0-0367.....	271
Table A.33 – List index of AT data container B.....	271
Table A.34 – Attributes for IDN S-0-0368.....	272
Table A.35 – Data container A pointer structure.....	273
Table A.36 – Attributes for IDN S-0-0369.....	273
Table A.37 – Data container B pointer structure.....	274
Table A.38 – Attributes for IDN S-0-0370.....	274
Table A.39 – Attributes for IDN S-0-0371.....	275
Table A.40 – Attributes for IDN S-0-0394.....	276
Table A.41 – Attributes for IDN S-0-0395.....	276
Table A.42 – Attributes for IDN S-0-0396.....	277
Table A.43 – Attributes for IDN S-0-0397.....	278
Table A.44 – Attributes for IDN S-0-0398.....	279
Table A.45 – Attributes for IDN S-0-0399.....	279
Table A.46 – Attributes for IDN S-0-0444.....	280
Table A.47 – Attributes for IDN S-0-0445.....	281
Table A.48 – Attributes for IDN S-0-0450.....	281
Table A.49 – Attributes for IDN S-0-0451.....	282
Table A.50 – Attributes for IDN S-0-0452.....	283
Table A.51 – Attributes for IDN S-0-0453.....	284
Table A.52 – Attributes for IDN S-0-0454.....	285
Table A.53 – Attributes for IDN S-0-0455.....	286
Table A.54 – Attributes for IDN S-0-0456.....	287
Table A.55 – Attributes for IDN S-0-0457.....	288
Table A.56 – Attributes for IDN S-0-0458.....	289
Table A.57 – Attributes for IDN S-0-0459.....	290
Table A.58 – Attributes for IDN S-0-0480.....	291
Table A.59 – Attributes for IDN S-0-0481.....	292
Table A.60 – Attributes for IDN S-0-0482.....	293
Table A.61 – Attributes for IDN S-0-0483.....	294
Table A.62 – Attributes for IDN S-0-0484.....	295
Table A.63 – Attributes for IDN S-0-0485.....	296
Table A.64 – Attributes for IDN S-0-0486.....	297
Table A.65 – Attributes for IDN S-0-0487.....	298
Table A.66 – Attributes for IDN S-0-0488.....	299
Table A.67 – Attributes for IDN S-0-0489.....	300
Table A.68 – Attributes for IDN S-0-0490.....	301
Table A.69 – Attributes for IDN S-0-0491.....	301

Table A.70 – Attributes for IDN S-0-0492	302
Table A.71 – Attributes for IDN S-0-0493	303
Table A.72 – Attributes for IDN S-0-0494	303
Table A.73 – Attributes for IDN S-0-0495	304
Table A.74 – Attributes for IDN S-0-0496	305
Table A.75 – Attributes for IDN S-0-0497	305
Table A.76 – Attributes for IDN S-0-0498	306
Table A.77 – Attributes for IDN S-0-0500	307
Table A.78 – Attributes for IDN S-0-0501	307
Table A.79 – Attributes for IDN S-0-0502	308
Table A.80 – Attributes for IDN S-0-0503	309
Table A.81 – Attributes for IDN S-0-0504	309
Table A.82 – Attributes for IDN S-0-0505	310
Table A.83 – Attributes for IDN S-0-0506	311
Table A.84 – Attributes for IDN S-0-0507	311
Table A.85 – Attributes for IDN S-0-0508	312
Table A.86 – Attributes of IDN S-0-1000.0.0	313
Table A.87 – SCP type and version	314
Table A.88 – Attributes of IDN S-0-1000.0.1	316
Table A.89 – Attributes of IDN S-0-1000.0.2	317
Table A.90 – Communication compatible status	317
Table A.91 – Attributes of IDN S-0-1002	318
Table A.92 – Attributes of IDN S-0-1003	318
Table A.93 – Attributes of IDN S-0-1005	319
Table A.94 – Attributes of IDN S-0-1006	320
Table A.95 – Attributes for IDN S-0-1007	321
Table A.96 – Attributes for IDN S-0-1008	322
Table A.97 – Attributes of IDN S-0-1009	322
Table A.98 – C-DEV Offset in MDT	323
Table A.99 – Attributes of IDN S-0-1010	323
Table A.100 – Attributes of IDN S-0-1011	325
Table A.101 – S-DEV Offset in AT	325
Table A.102 – Attributes of IDN S-0-1012	326
Table A.103 – Attributes of IDN S-0-1013	327
Table A.104 – SVC Offset in MDT	327
Table A.105 – Attributes of IDN S-0-1014	328
Table A.106 – SVC Offset in AT	328
Table A.107 – Attributes of IDN S-0-1015	329
Table A.108 – Attributes of IDN S-0-1016	329
Table A.109 – Attributes of IDN S-0-1017	330
Table A.110 – Attributes of IDN S-0-1019	331
Table A.111 – Attributes of IDN S-0-1020.0.1	332
Table A.112 – Attributes of IDN S-0-1020	332

Table A.113 – Attributes of IDN S-0-1021.0.1	333
Table A.114 – Attributes of IDN S-0-1021	334
Table A.115 – Attributes of IDN S-0-1022.0.1	335
Table A.116 – Attributes of IDN S-0-1022	335
Table A.117 – Attributes of IDN S-0-1023	336
Table A.118 – Attributes of IDN S-0-1024	338
Table A.119 – Attributes of IDN S-0-1026	339
Table A.120 – Attributes of IDN S-0-1027.0.1	339
Table A.121 – Upper and lower Limit of MTU	340
Table A.122 – Attributes of IDN S-0-1027.0.2	341
Table A.123 – Attributes of IDN S-0-1028	341
Table A.124 – Attributes of IDN S-0-1031	342
Table A.125 – Structure of test pin assignment Port 1 & Port 2	342
Table A.126 – Selectable output signals	343
Table A.127 – Attributes of IDN S-0-1032	343
Table A.128 – Communication control.....	344
Table A.129 – Attributes of IDN S-0-1035	344
Table A.130 – Coding of PHY errors	345
Table A.131 – Attributes of IDN S-0-1035.0.01	345
Table A.132 – Checking of MAC telegrams	346
Table A.133 – Attributes of IDN S-0-1035.0.0	347
Table A.134 – Checking of MAC telegrams	347
Table A.135 – Attributes of IDN S-0-1036	348
Table A.136 – Attributes of IDN S-0-1037	349
Table A.137 – Attributes of IDN S-0-1039.0.1	350
Table A.138 – Attributes of IDN S-0-1039	351
Table A.139 – Attributes of IDN S-0-1040	351
Table A.140 – Attributes of IDN S-0-1041	352
Table A.141 – Attributes of IDN S-0-1042	353
Table A.142 – Structure of topology index.....	354
Table A.143 – Topology index (Example 1).....	354
Table A.144 – Topology index (Example 2).....	354
Table A.145 – Attributes of IDN S-0-1044	355
Table A.146 – Device control field (C-DEV)	355
Table A.147 – Attributes of IDN S-0-1045	356
Table A.148 – Device status field.....	356
Table A.149 – Attributes of IDN S-0-1046	358
Table A.150 – Attributes of IDN S-0-1047	359
Table A.151 – Attributes of IDN S-0-1048	360
Table A.152 – Attributes of IDN S-0-1050.x.01.....	361
Table A.153 – Connection setup	361
Table A.154 – Attributes of IDN S-0-1050.x.02.....	362
Table A.155 – Attributes of IDN S-0-1050.x.03.....	363

Table A.156 – Structure of telegram assignment.....	364
Table A.157 – Attributes of IDN S-0-1050.x.04.....	364
Table A.158 – Attributes of IDN S-0-1050.x.05.....	365
Table A.159 – Attributes of IDN S-0-1050.x.06.....	366
Table A.160 – Attributes of IDN S-0-1050.x.07.....	366
Table A.161 – Attributes of IDN S-0-1050.x.08.....	367
Table A.162 – Attributes of IDN S-0-1050.x.09.....	367
Table A.163 – Connection states	368
Table A.164 – Attributes of IDN S-0-1050.x.10.....	368
Table A.165 – Attributes of IDN S-0-1050.x.11.....	369
Table A.166 – Attributes of IDN S-0-1050.x.12.....	369
Table A.167 – Attributes of IDN S-0-1050.x.20.....	370
Table A.168 – Attributes of IDN S-0-1050.x.21.....	371
Table A.169 – Attributes of IDN S-0-1051	371
Table A.170 – Attributes of IDN S-0-1060.x.01.....	372
Table A.171 – Attributes of IDN S-0-1060.x.02.....	372
Table A.172 – Attributes of IDN S-0-1060.x.03.....	373
Table A.173 – Attributes of IDN S-0-1060.x.04.....	374
Table A.174 – Attributes of IDN S-0-1060.x.06.....	374
Table A.175 – Attributes of IDN S-0-1060.x.07.....	375
Table A.176 – Attributes of IDN S-0-1060.x.10.....	376
Table A.177 – Attributes of IDN S-0-1061	376
Table A.178 – Attributes of IDN S-0-1080.x.02.....	377
Table A.179 – Attributes of IDN S-0-1080.x.03.....	378
Table A.180 – Attributes of IDN S-0-1080.x.04.....	378
Table A.181 – Attributes of IDN S-0-1081.x.02.....	379
Table A.182 – Attributes of IDN S-0-1081.x.03.....	380
Table A.183 – Attributes of IDN S-0-1081.x.04.....	380
Table A.184 – Attributes of IDN S-0-1099.0.1	381
Table A.185 – Structure of Test-IDN control.....	381
Table A.186 – Attributes of IDN S-0-1099.0.2	382
Table A.187 – Attributes of IDN S-0-1100.0.01	382
Table A.188 – Attributes of IDN S-0-1100.0.02	383
Table A.189 – Attributes of IDN S-0-1100.0.03	384
Table A.190 – Attributes of IDN S-0-1101.x.01.....	384
Table A.191 – Attributes of IDN S-0-1101.x.02.....	385
Table A.192 – Attributes of IDN S-0-1101.x.03.....	386
Table A.193 – Attributes of IDN S-0-1150.x.01.....	386
Table A.194 – OVS Control structure	387
Table A.195 – Attributes of IDN S-0-1150.x.02.....	387
Table A.196 – OVS Status structure	388
Table A.197 – Attributes of IDN S-0-1150.x.03.....	388
Table A.198 – Configuration example	389

Table A.199 – Attributes of IDN S-0-1150.x.04.....	389
Table A.200 – Attributes of IDN S-0-1150.x.05.....	390
Table A.201 – Attributes of IDN S-0-1150.x.06.....	391
Table A.202 – Attributes of IDN S-0-1150.x.07.....	391
Table A.203 – Attributes of IDN S-0-1150.x.08.....	392
Table A.204 – Attributes of IDN S-0-1150.x.09.....	393
Table A.205 – Attributes of IDN S-0-1150.x.10.....	393
Table A.206 – Attributes of IDN S-0-1151.x.01.....	394
Table A.207 – Attributes of IDN S-0-1151.x.02.....	395
Table A.208 – Attributes of IDN S-0-1151.x.03.....	395
Table A.209 – Attributes of IDN S-0-1151.x.04.....	396
Table A.210 – Attributes of IDN S-0-1151.x.06.....	396
Table A.211 – Attributes of IDN S-0-1151.x.07.....	397
Table A.212 – Attributes of IDN S-0-1151.x.08.....	398
Table A.213 – Attributes of IDN S-0-1152	398
Table C.1 – Type 19 LED.....	417
Table C.2 – SDx LED	418
Table C.3 – List of relevant communication-related IDNs	428
Table C.4 – Attributes of IDN S-0-0000	429
Table C.5 – Attributes of IDN S-0-0017	430
Table C.6 – Attributes of IDN S-0-0025.....	430
Table C.7 – Attributes of IDN S-0-0095.....	431
Table C.8 – Attributes of IDN S-0-0099.....	431
Table C.9 – Attributes of IDN S-0-0192.....	432
Table C.10 – Attributes of IDN S-0-0262.....	433
Table C.11 – Attributes of IDN S-0-0263.....	433
Table C.12 – Attributes of IDN S-0-0264.....	434
Table C.13 – Attributes of IDN S-0-0265.....	434
Table C.14 – Language codes	435
Table C.15 – Attributes of IDN S-0-0266.....	435
Table C.16 – Attributes of IDN S-0-0267.....	436
Table C.17 – States of the password state machine.....	437
Table C.18 – Transitions of the password state machine.....	438
Table C.19 – Changing the password.....	438
Table C.20 – Attributes of IDN S-0-0269.....	439
Table C.21 – Structure of storage mode.....	439
Table C.22 – Attributes of IDN S-0-0270.....	440
Table C.23 – Attributes of IDN S-0-0279.....	440
Table C.24 – Attributes of IDN S-0-0293.....	441
Table C.25 – Attributes of IDN S-0-0326.x.00	442
Table C.26 – Attributes of IDN S-0-0327.x.00	442
Table C.27 – Attributes of IDN S-0-0390.....	443
Table C.28 – Prioritization of diagnostic events.....	444

Table C.29 – Transitions of the password state machine.....	445
Table C.30 – Attributes of IDN S-0-0420	446
Table C.31 – Attributes of IDN S-0-0422	446
Table C.32 – Attributes of IDN S-0-0423	447
Table C.33 – Attributes of IDN S-0-0425	448
Table C.34 – Structure of the sub-device state machine control	448
Table C.35 – Attributes of IDN S-0-0531	449
Table C.36 – Attributes of IDN S-0-1300.x.1	449
Table C.37 – Attributes of IDN S-0-1300.x.2	450
Table C.38 – Attributes of IDN S-0-1300.x.3	450
Table C.39 – Vendor code	451
Table C.40 – Attributes of IDN S-0-1300.x.4	451
Table C.41 – Attributes of IDN S-0-1300.x.5	452
Table C.42 – Attributes of IDN S-0-1300.x.6	452
Table C.43 – Attributes of IDN S-0-1300.x.7	453
Table C.44 – Attributes of IDN S-0-1300.x.8	453
Table C.45 – Attributes of IDN S-0-1300.x.9	454
Table C.46 – Attributes of IDN S-0-1300.x.10	455
Table C.47 – Attributes of IDN S-0-1300.x.11	455
Table C.48 – Attributes of IDN S-0-1300.x.12	456
Table C.49 – Attributes of IDN S-0-1300.x.13	456
Table C.50 – Attributes of IDN S-0-1300.x.14	457
Table C.51 – Attributes of IDN S-0-1300.x.20	458
Table C.52 – Attributes of IDN S-0-1300.x.21	459
Table C.53 – Attributes of IDN S-0-1300.x.22	460
Table C.54 – Attributes of IDN S-0-1300.x.23	461
Table C.55 – Attributes of IDN S-0-1301	462
Table C.56 – Structure of GDP classes & version	462
Table C.57 – Attributes of IDN S-0-1302.x.1	463
Table C.58 – Coding of S-1302.x.01	463
Table C.59 – Attributes of IDN S-0-1302.x.2	464
Table C.60 – Attributes of IDN S-0-1302.x.3	466
Table C.61 – Attributes of IDN S-0-1303.0.1	466
Table C.62 – Attributes of IDN S-0-1303.0.2	467
Table C.63 – Coding of S-1303.0.02	468
Table C.64 – Attributes of IDN S-0-1303.0.3	468
Table C.65 – Coding of S-1303.0.2	469
Table C.66 – Attributes of IDN S-0-1303.0.10	469
Table C.67 – Attributes of IDN S-0-1303.0.11	470
Table C.68 – Attributes of IDN S-0-1303.0.12	471
Table C.69 – Attributes of IDN S-0-1305.0.1	471
Table C.70 – Structure of Type 19 time.....	472
Table C.71 – Attributes of IDN S-0-1305.0.2	472

Table C.72 – Attributes of IDN S-0-1310 473

Table C.73 – Attributes of IDN S-0-1350 473

Table C.74 – Attributes of IDN S-0-1310 474

Table C.75 – Structure of Test IDN Diagnostic Event 475

Table C.76 – Status codes with the diagnosis class "operational state" 476

Table C.77 – Status codes with the diagnosis class "procedure command specific state" 476

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
FIELDBUS SPECIFICATIONS –****Part 4-19: Data-link layer protocol specification –
Type 19 elements**

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International Standard IEC 61158-4-19 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:

- improving the hotplug and redundancy features;
- improving the phase switching and the error handling;
- editorial improvements.

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

FDIS	Report on voting
65C/946/FDIS	65C/955/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 the ISO/IEC Directives, Part 2.

A list of all the 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.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour 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 data-link protocol provides the data-link service by making use of the services available from the physical 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 data-link entities (DLEs) 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:

- a) as a guide for implementors and designers;
- b) for use in the testing and procurement of equipment;
- c) as part of an agreement for the admittance of systems into the open systems environment;
- d) 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 profile parts. Use of the various protocol type(s) in other combinations may require permission from their respective intellectual-property-right holders.

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DE 102 00 502 4759.8-32	[BR]	Verfahren zur Laufzeitkorrektur in einer Kommunikationsstruktur
DE 102 37 097	[RI]	Korrektur von Signallaufzeiten in verteilten Kommunikationssystemen

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-19: Data-link layer protocol specification – Type 19 elements

1 Scope

1.1 General

The data-link layer provides basic time-critical messaging communications between devices in an automation environment.

This protocol provides communication opportunities to all participating data-link entities

- a) in a synchronously-starting cyclic manner, according to a pre-established schedule, and
- b) in a cyclic or acyclic asynchronous manner, as requested each cycle by each of those data-link entities.

Thus this protocol can be characterized as one which provides cyclic and acyclic access asynchronously but with a synchronous restart of each cycle.

1.2 Specifications

This document specifies

- a) procedures for the timely transfer of data and control information from one data-link user entity to a peer user entity, and among the data-link entities forming the distributed data-link service provider;
- b) the structure of the fieldbus DLPDUs used for the transfer of data and control information by the protocol of this document, and their representation as physical interface data units.

1.3 Procedures

The procedures are defined in terms of

- a) the interactions between peer DL-entities (DLEs) through the exchange of fieldbus DLPDUs;
- b) the interactions between a DL-service (DLS) provider and a DLS-user in the same system through the exchange of DLS primitives;
- c) the interactions between a DLS-provider and a Ph-service provider in the same system through the exchange of Ph-service primitives.

1.4 Applicability

These procedures are applicable to instances of communication between systems which support time-critical communications services within the data-link layer of the OSI or fieldbus reference models, and which require the ability to interconnect in an open systems interconnection environment.

Profiles provide a simple multi-attribute means of summarizing an implementation's capabilities, and thus its applicability to various time-critical communications needs.

1.5 Conformance

This document also specifies conformance requirements for systems implementing these procedures. This part of this document does not contain tests to demonstrate compliance with such requirements.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE All parts of the IEC 61158 series, as well as IEC 61784-1 and IEC 61784-2 are maintained simultaneously. Cross-references to these documents within the text therefore refer to the editions as dated in this list of normative references.

IEC 61158-4-16:2007, *Industrial communication networks – Fieldbus specifications – Part 4-16: Data-link layer protocol specification – Type 16 elements*

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

ISO/IEC 7498-3, *Information technology – Open Systems Interconnection – Part 3: Basic Reference Model: Naming and addressing*

ISO/IEC/IEEE 8802-3, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet*

ISO 8601, *Data elements and interchange formats – Information interchange – Representation of dates and times*

IEEE Std 802.3, *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications*

Internet Engineering Task Force (IETF), *Request for Comments (RFC): RFC 879, The TCP Maximum Segment Size and Related Topics* (available at <<http://www.ietf.org/rfc/rfc0879.txt>>) [viewed 2018-09-13]

3 Terms, definitions, symbols, acronyms, abbreviations and conventions

For the purposes of this document, the following terms, definitions, symbols, acronyms, abbreviations and conventions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 Reference model terms and definitions

This document is based in part on the concepts developed in ISO/IEC 7498-1 and ISO/IEC 7498-3, and makes use of the following terms defined therein.

3.2 Additional Type 19 terms and definitions

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

3.2.1

broadcast

transmission to all devices in a network without any acknowledgment by the receivers

3.2.2

communication cycle

fixed time period between two master synchronization telegrams in which real-time telegrams are transmitted in the RT channel and non-real-time telegrams are transmitted in the IP channel

3.2.3

control unit

control device (for example, a PLC as specified in the IEC 61131)

3.2.4

control word

two adjacent octets inside the master data telegram containing commands for the addressed device

3.2.5

cross communication

direct multicast data transfer between devices

3.2.6

cycle time

duration of a communication cycle

3.2.7

cyclic communication

periodic exchange of telegrams

3.2.8

cyclic data

part of a telegram, which does not change its meaning during cyclic operation of the network

3.2.9

cyclic operation

operation in which devices in the communication network are addressed and queried one after the other at fixed, constant time intervals

3.2.10

device

a slave in the communication network, (for example, a power drive system as defined in IEC 61800-7 (all parts), I/O stations as defined in IEC 61131 (all parts))

3.2.11

device address field

address field (eight bits) containing the address of the device

3.2.12

device control

four adjacent octets inside the master data telegram containing commands for each device

3.2.13**device status**

four adjacent octets inside the acknowledge telegram containing status information for each device

3.2.14**DLE station identifier**

network address assigned to a DLE

3.2.15**DLE station slot**

unit (granularity of one) of position dependent mapping (for cyclic data field) of which a DLE may occupy one or more, delineated by the range beginning at the DLE station identifier with a length equal to the configured number of occupied slots

3.2.16**element**

part of IDNs – each IDN has 7 elements, whereas each one has a specific meaning (for example: number, name, data)

3.2.17**EtherType**

part of the Type 19 specific telegram header

3.2.18**forwarding**

mode by which a device passes on a received telegram to the other port, either changed or unchanged

3.2.19**identification number****IDN**

designation of operating data under which a data block is preserved with its attribute, name, unit, minimum and maximum input values, and the data

3.2.20**line****line structure**

network topology, in which the transmission medium is routed from station to station in the form of a line; the information is transmitted in one direction from the master down to the last slave in the line, and then flows back to the master via all the slaves in the reverse order (CP16/3)

3.2.21**loopback**

mode by which a device passes on a received telegram to the same port and to the other port, either changed or unchanged

3.2.22**master**

node, which assigns the other nodes (i.e., slaves) the right to transmit

3.2.23**master data telegram****MDT**

telegram, in which the master inserts its data

3.2.24

master DLE

DLE that performs the functions of network master

3.2.25

master synchronization telegram

MST

telegram, or part of a telegram, in which the master inserts a time synchronization signal

3.2.26

MDT0 telegram

telegram, in which the master transmits its synchronization data, as well as parts or all of its real-time data, to the slaves

3.2.27

participant

node which is connected to the network

3.2.28

physical layer

first layer of the ISO-OSI reference model

3.2.29

protocol

convention about the data formats, time sequences, and error correction in the data exchange of communication systems

3.2.30

real-time data

part of the telegram that does not change its meaning during cyclic operation of the interface

3.2.31

RT channel

defined time slot within the communication cycle, which passes the CPF16 real-time telegrams

3.2.32

service channel

SVC

non real-time transmission of information upon master request during RT channel

3.2.33

slave

node, which is assigned the right to transmit by the master

3.2.34

slave DLE

DLE that performs the functions of network slave

3.2.35

station

node which is connected to the network

3.2.36

status word

two adjacent octets inside the acknowledge telegram containing status information of a device

3.2.37**S-0-nnnn**

designation of IDNs

3.2.38**telegram**

DLPDU

3.2.39**topology**

physical network architecture with respect to the connection between the stations of the communication system

3.2.40**topology index**

position of a slave in a Type 19 network using a daisy chain numeration starting with value 1 at the first slave after the master

3.3 Symbols

ADR	device address ($1 \leq \text{ADR} \leq 511$) adjusted directly on the device, for example using a selector switch
AT MST	header in AT
AT0...3	acknowledge telegrams
INFO	service channel information
JtScyc	jitter in tScyc
MDT0	master data telegram with synchronization data that the slaves evaluates
MDT1...3	master data telegrams without synchronization data
P1	port 1
P2	port 2
RxD	received data
SLKN	slave identification parameter, slave arrangement
SVC	service channel
t1	AT transmission starting time
t1min	shortest AT transmission starting time
t3	command value valid time
t4	feedback acquisition capture point
t5	minimum feedback processing time
tcable	time, by which the transmitted signal is delayed by the cable, for each unit of length (approx., 5 ns/m)
trep	time, by which the received signal is delayed by a forwarding slave (input-output)
tRing	time, which a master telegram needs, until it has passed through the network and reached the master again

tScyc	communication cycle time
TxD	transmitted data

3.4 Acronyms and abbreviations

AHS	service transport handshake of the device (acknowledge HS)
AT	acknowledge telegram
C-CON	connection control
C-DEV	device control
C1D	class 1 diagnostic
CP	communication phase
CPS	communication phase switching
CRC	cyclic redundancy check
CSoS	CIP Safety on SERCOS
FCS	DLPDU check sequence
FG	Function Group
FSP	Function-specific Profile
GDP	Generic Device Profile
HP	Hot-Plug
HP0	Hot-Plug phase 0
HP1	Hot-Plug phase 1
HP2	Hot-Plug phase 2
HS	service channel handshake (see AHS and MHS)
IDN	identification number
IP	Internet protocol
MAC	media access control
MDT	master data telegram
MDT MST	header in MDT
MHS	service transport handshake of the master
MS	communication from slave to master
MST	master synchronization telegram
NRT	non real-time
P-channel	primary channel
P-telegram	primary telegram

PL	parametrization level
RT	real-time
RTC	real-time channel
RTD	real-time data in MDT or AT
S-DEV	device status
S-channel	secondary channel
S-telegram	secondary telegram
SCH	session control header
SCP	Type 19 Communication Profile
SE	structure element
SERCOS	serial real-time communication system interface
SFD	start DLPDU delimiter
SI	structure instance
SMP	Type 19 Messaging Protocol
SVC	service channel
UCC	unified communication channel

3.5 Additional conventions

All data types are assigned identification numbers (IDNs). They include real-time data (commands and feedback values), parameters, and procedures. Most IDNs are similar to those for Type 16 (see IEC 61158-4-16, 3.6). Several IDNs relate to the application and are defined in their relevant standards (for example, IEC 61800-7-20x for Power Drive Systems).

Refer to Annex A for additional information, as well as to IEC 61158-4-16, Clause A.1 for detailed IDN specification.

4 DL-protocol overview

4.1 Overview

This protocol type provides a highly optimized means of interchanging fixed-length real-time data and variable-length segmented messages between a single master device and a set of slave devices, interconnected in a ring or a line topology. The ring topology provides for redundant communication paths, and in case of a fault it automatically switches to a set of two lines without disturbing the communication.

This protocol type also provides for direct real-time data transmission between slaves, inside the real-time channel (RTC), within each communication cycle.

The exchange of real-time data is totally synchronous by configuration and is unaffected by the messaging traffic.