IEC 61158-2

Edition 5.0 2010-07

INTERNATIONAL STANDARD

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Industrial communication networks – Fieldbus specifications – Part 2: Physical layer specification and service definition

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE XN

ICS, 25.040, 35.100, 35.240.50

ISBN 978-2-88912-051-2

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CONTENTS

FOREWORD 14
0 Introduction 16
1 Scope 20
2 Normative references 20
3 Terms and definitions 22
4 Symbols and abbreviations 45
5 DLL – PhL interface 56
6 Systems management – PhL interface 77
7 DCE independent sublayer (DIS) 91
8 DTE – DCE interface and MIS-specific functions 93
9 Medium dependent sublayer (MDS) 114
10 MDS – MAU interface 135
11 Types 1 and 7: Medium attachment unit: voltage mode, linear-bus-topology 150 Ω twisted-pair wire medium 143
12 Types 1 and 3: Medium attachment unit: 31,25 kbit/s, voltage-mode with low-power option, bus- and tree-topology, 100 Ω wire medium 158
13 Type 1: Medium attachment unit: current mode, twisted-pair wire medium 175
14 Type 1: Medium attachment unit: current mode (1 A), twisted-pair wire medium 185
15 Types 1 and 7: Medium attachment unit: dual-fiber optical media 194
16 Type 1: Medium attachment unit: 31,25 kbit/s, single-fiber optical medium 201
17 Type 1: Medium attachment unit: radio signaling 204
18 Type 2: Medium attachment unit: 5 Mbit/s, voltage-mode, coaxial wire medium 214
19 Type 2: Medium attachment unit: 5 Mbit/s, optical medium 226
20 Type 2: Medium attachment unit: network access port (NAP) 231
21 Type 3: Medium attachment unit: synchronous transmission, 31,25 kbit/s, voltage mode, wire medium 234
22 Type 3: Medium attachment unit: asynchronous transmission, wire medium 251
23 Type 3: Medium attachment unit: asynchronous transmission, optical medium 268
24 Type 4: Medium attachment unit: RS-485 277
25 Type 4: Medium attachment unit: RS-232 279
26 Type 6: *This clause has been removed* 280
27 Type 8: Medium attachment unit: twisted-pair wire medium 280
28 Type 8: Medium attachment unit: optical media 285
29 Type 12: Medium attachment unit: electrical medium 292
30 Type 16: Medium attachment unit: optical fiber medium at 2, 4, 8 and 16 Mbit/s 294
31 Type 18: Medium attachment unit: basic medium 307
32 Type 18: Medium attachment unit: powered medium 311
Annex A (normative) Type 1: Connector specification 320
Annex B (informative) Types 1 and 3: Cable specifications and trunk and spur lengths for the 31,25 kbit/s voltage-mode MAU 328
Annex C (informative) Types 1 and 7: Optical passive stars 330
Annex D (informative) Types 1 and 7: Star topology 331

Annex E (informative) Type 1: Alternate fibers 335
Annex F (normative) Type 2: Connector specification 336
Annex G (normative) Type 2: Repeater machine sublayers (RM, RRM) and redundant PhLs 339
Annex H (informative) Type 2: Reference design examples 350
Annex I (normative) Type 3: Connector specification 356
Annex J (normative) Type 3: Redundancy of PhL and medium 363
Annex K (normative) Type 3: Optical network topology 364
Annex L (informative) Type 3: Reference design examples for asynchronous transmission, wire medium, intrinsically safe 373
Annex M (normative) Type 8: Connector specification 375
Annex N (normative) Type 16: Connector specification 380
Annex O (normative) Type 16: Optical network topology 381
Annex P (informative) Type 16: Reference design example 386
Annex Q (normative) Type 18: Connector specification 390
Annex R (normative) Type 18: Media cable specifications 395
Bibliography 399

Figure 1 – General model of physical layer 17
Figure 2 – Mapping between data units across the DLL – PhL interface 57
Figure 3 – Data service for asynchronous transmission 62
Figure 4 – Interactions for a data sequence of a master: identification cycle 67
Figure 5 – Interactions for a data sequence of a master: data cycle 68
Figure 6 – Interactions for a data sequence of a slave: identification cycle 69
Figure 7 – Interactions for a data sequence of a slave: data cycle 70
Figure 8 – Interactions for a check sequence of a master 71
Figure 9 – Interactions for a check sequence of a slave 72
Figure 10 – Reset, Set-value, Get-value 81
Figure 11 – Event service 81
Figure 12 – Interface between PhL and PNM1 in the layer model 86
Figure 13 – Reset, Set-value, Get-value PhL services 87
Figure 14 – Event PhL service 87
Figure 15 – Allocation of the interface number 88
Figure 16 – Configuration of a master 92
Figure 17 – Configuration of a slave with an alternative type of transmission 93
Figure 18 – Configuration of a bus coupler with an alternative type of transmission 93
Figure 19 – DTE/DCE sequencing machines 98
Figure 20 – State transitions with the ID cycle request service 107
Figure 21 – MIS-MDS interface: identification cycle request service 108
Figure 22 – MIS-MDS interface: identification cycle request service 109
Figure 23 – State transitions with the data cycle request service 109
Figure 24 – MIS-MDS interface: data cycle request service 110
Figure 25 – State transitions with the data sequence classification service 110
Figure 26 – Protocol machine for the message transmission service 111

Figure 27 – Protocol machine for the data sequence identification service 112
Figure 28 – Protocol machine for the message receipt service 113
Figure 29 – Protocol data unit (PhPDU) 114
Figure 30 – PhSDU encoding and decoding 115
Figure 31 – Manchester encoding rules 115
Figure 32 – Preamble and delimiters 117
Figure 33 – Manchester coded symbols 118
Figure 34 – PhPDU format, half duplex 119
Figure 35 – PhPDU format, full duplex 121
Figure 36 – Data sequence PhPDU 125
Figure 37 – Structure of the header in a data sequence PhPDU 125
Figure 38 – Check sequence PhPDU 126
Figure 39 – Structure of a headers in a check sequence PhPDU 126
Figure 40 – Structure of the status PhPDU 127
Figure 41 – Structure of the header in a status PhPDU 127
Figure 42 – Structure of the medium activity status PhPDU 128
Figure 43 – Structure of the header in a medium activity status PhPDU 128
Figure 44 – Reset PhPDU 129
Figure 45 – Configuration of a master 130
Figure 46 – Configuration of a slave 130
Figure 47 – Configuration of a bus coupler 130
Figure 48 – Protocol data unit 131
Figure 49 – PhSDU encoding and decoding 131
Figure 50 – Manchester encoding rules 131
Figure 51 – Example of an NRZI-coded signal 134
Figure 52 – Fill signal 134
Figure 53 – Jitter tolerance 141
Figure 54 – Transmit circuit test configuration 147
Figure 55 – Output waveform 148
Figure 56 – Transmitted and received bit cell jitter (zero crossing point deviation) 149
Figure 57 – Signal polarity 150
Figure 58 – Receiver sensitivity and noise rejection 151
Figure 59 – Power supply ripple and noise 154
Figure 60 – Fieldbus coupler 156
Figure 61 – Transition from receiving to transmitting 163
Figure 62 – Power supply ripple and noise 167
Figure 63 – Test circuit for single-output power supplies 168
Figure 64 – Test circuit for power distribution through an IS barrier 169
Figure 65 – Test circuit for multiple output supplies with signal coupling 170
Figure 66 – Fieldbus coupler 172
Figure 67 – Protection resistors 172
Figure 68 – Test configuration for current-mode MAU 178
Figure 69 – Transmitted and received bit cell jitter (zero crossing point deviation) 179

Figure 70 – Noise test circuit for current-mode MAU 181
Figure 71 – Transmitted and received bit cell jitter (zero crossing point deviation) 189
Figure 72 – Power supply harmonic distortion and noise 192
Figure 73 – Optical wave shape template 197
Figure 74 – Cellular radio topology and reuse of frequencies 208
Figure 75 – Radio segment between wired segments topology 209
Figure 76 – Mixed wired and radio medium fieldbus topology 210
Figure 77 – Components of 5 Mbit/s, voltage-mode, coaxial wire PhL variant 215
Figure 78 – Coaxial wire MAU block diagram 215
Figure 79 – Coaxial wire MAU transmitter 216
Figure 80 – Coaxial wire MAU receiver operation 217
Figure 81 – Coaxial wire MAU transmit mask 218
Figure 82 – Coaxial wire MAU receive mask 219
Figure 83 – Transformer symbol 220
Figure 84 – 5 Mbit/s, voltage-mode, coaxial wire topology example 222
Figure 85 – Coaxial wire medium topology limits 223
Figure 86 – Coaxial wire medium tap electrical characteristics 224
Figure 87 – MAU block diagram 5 Mbit/s, optical fiber medium 227
Figure 88 – NAP reference model 231
Figure 89 – Example of transient and permanent nodes 232
Figure 90 – NAP transceiver 233
Figure 91 – NAP cable 234
Figure 92 – Circuit diagram of the principle of measuring impedance 239
Figure 93 – Definition of CMRR 240
Figure 94 – Block circuit diagram of the principle of measuring CMRR 240
Figure 95 – Power supply ripple and noise 243
Figure 96 – Output characteristic curve of a power supply of the category EEx ib 250
Figure 97 – Output characteristic curve of a power supply of the category EEx ia 250
Figure 98 – Repeater in linear bus topology 253
Figure 99 – Repeater in tree topology 253
Figure 100 – Example for a connector with integrated inductance 255
Figure 101 – Interconnecting wiring 255
Figure 102 – Bus terminator 256
Figure 103 – Linear structure of an intrinsically safe segment 258
Figure 104 – Topology example extended by repeaters 259
Figure 105 – Bus terminator 261
Figure 106 – Waveform of the differential voltage 262
Figure 107 – Test set-up for the measurement of the idle level for devices with an integrated termination resistor 264
Figure 108 – Test set-up for the measurement of the idle level for devices with a connectable termination resistor 264
Figure 109 – Test set-up for measurement of the transmission levels 265
Figure 110 – Test set-up for the measurement of the receiving levels 265
Figure 111 – Fieldbus model for intrinsic safety 266

Figure 112 – Communication device model for intrinsic safety 266
Figure 113 – Connection to the optical network 269
Figure 114 – Principle structure of optical networking 270
Figure 115 – Definition of the standard optical link 270
Figure 116 – Signal template for the optical transmitter 275
Figure 117 – Recommended interface circuit 279
Figure 118 – MAU of an outgoing interface 280
Figure 119 – MAU of an incoming interface 281
Figure 120 – Remote bus link 281
Figure 121 – Interface to the transmission medium 282
Figure 122 – Wiring 285
Figure 123 – Terminal resistor network 285
Figure 124 – Fiber optic remote bus cable 286
Figure 125 – Optical fiber remote bus link 286
Figure 126 – Optical wave shape template optical MAU 288
Figure 127 – Optical transmission line 294
Figure 128 – Optical signal envelope 296
Figure 129 – Display of jitter (J_{noise}) 297
Figure 130 – Input-output performance of a slave 299
Figure 131 – Functions of a master connection 302
Figure 132 – Valid transmitting signals during the transition from fill signal to telegram delimiters 304
Figure 133 – Valid transmitting signals during the transition from telegram delimiter to fill signal 305
Figure 134 – Functions of a slave connection 306
Figure 135 – Network with two slaves 307
Figure 136 – Minimum interconnecting wiring 308
Figure 137 – Dedicated cable topology 309
Figure 138 – T-branch topology 309
Figure 139 – Communication element isolation 311
Figure 140 – Communication element and I/O isolation 311
Figure 141 – Minimum interconnecting wiring 312
Figure 142 – Flat cable topology 313
Figure 143 – Dedicated cable topology 313
Figure 144 – T-branch topology 313
Figure 145 – Type 18-PhL-P power distribution 316
Figure 146 – Type 18-PhL-P power distribution 316
Figure 147 – Type 18-PhL-P power supply filtering and protection 318
Figure 148 – Communication element isolation 318
Figure 149 – Communication element and i/o isolation 318
Figure 150 – PhL-P power supply circuit 319
Figure A.1 – Internal fieldbus connector 320
Figure A.2 – Contact designations for the external connector for harsh industrial environments 322

Figure A.3 – External fieldbus connector keyways, keys, and bayonet pins and grooves 322
Figure A.4 – External fieldbus connector intermateability dimensions 323
Figure A.5 – External fieldbus connector contact arrangement 324
Figure A.6 – Contact designations for the external connector for typical industrial environments 325
Figure A.7 – External fixed (device) side connector for typical industrial environments: dimensions 325
Figure A.8 – External free (cable) side connector for typical industrial environments: dimensions 326
Figure A.9 – Optical connector for typical industrial environments (FC connector) 326
Figure A.10 – Optical connector for typical industrial environments (ST connector) 327
Figure C.1 – Example of an optical passive reflective star 330
Figure C.2 – Example of an optical passive transmitive star 330
Figure D.1 – Example of star topology with 31,25 kbit/s, single fiber mode, optical MAU 331
Figure D.2 – Multi-star topology with an optical MAU 331
Figure D.3 – Example of mixture between wire and optical media for a 31,25 kbit/s bit rate 333
Figure D.4 – Example of mixture between wire and optical media 334
Figure F.1 – Pin connector for short range optical medium 337
Figure F.2 – Crimp ring for short range optical medium 337
Figure G.1 – PhL repeater device reference model 339
Figure G.2 – Reference model for redundancy 342
Figure G.3 – Block diagram showing redundant coaxial medium and NAP 343
Figure G.4 – Block diagram showing ring repeaters 344
Figure G.5 – Segmentation query 345
Figure G.6 – Segmentation response 345
Figure G.7 – Main switch state machine 347
Figure G.8 – Port 1 sees network activity first 348
Figure G.9 – Port 2 sees network activity first 349
Figure H.1 – Coaxial wire MAU RxDATA detector 351
Figure H.2 – Coaxial wire MAU RxCARRIER detection 352
Figure H.3 – Redundant coaxial wire MAU transceiver 352
Figure H.4 – Single channel coaxial wire MAU transceiver 353
Figure H.5 – Coaxial wire medium tap 354
Figure H.6 – Non-isolated NAP transceiver 355
Figure H.7 – Isolated NAP transceiver 355
Figure I.1 – Schematic of the station coupler 356
Figure I.2 – Pin assignment of the male and female connectors IEC 60947-5-2 (A coding) 357
Figure I.3 – Connector pinout, front view of male and back view of female respectively 358
Figure I.4 – Connector pinout, front view of female M12 connector 360
Figure I.5 – Connector pinout, front view of male M12 connector 360
Figure I.6 – M12 Tee 361
Figure I.7 – M12 Bus termination 362
Figure J.1 – Redundancy of PhL MAU and Medium 363

Figure K.1 – Optical MAU in a network with echo 364
Figure K.2 – Optical MAU in a network without echo 365
Figure K.3 – Optical MAU with echo via internal electrical feedback of the receive signal 365
Figure K.4 – Optical MAU without echo function 365
Figure K.5 – Optical network with star topology 366
Figure K.6 – Optical network with ring topology 367
Figure K.7 – Optical network with bus topology 367
Figure K.8 – Tree structure built from a combination of star structures 368
Figure K.9 – Application example for an ANSI TIA/EIA-485-A / fiber optic converter 368
Figure L.1 – Bus termination integrated in the communication device 373
Figure L.2 – Bus termination in the connector 374
Figure L.3 – External bus termination 374
Figure M.1 – Outgoing interface 9-position female subminiature D connector at the device 375
Figure M.2 – Incoming interface 9-position male subminiature D connector at the device 375
Figure M.3 – Terminal connector at the device 375
Figure M.4 – Ferrule of an optical F-SMA connector for polymer optical fiber (980/1 000 μm) 376
Figure M.5 – Type 8 fiber optic hybrid connector housing 377
Figure M.6 – Type 8 fiber optic hybrid connector assignment 378
Figure O.1 – Topology 381
Figure O.2 – Structure of a single-core cable (example) 384
Figure O.3 – Optical power levels 385
Figure P.1 – Example of an implemented DPLL 387
Figure P.2 – DPLL status diagram 388
Figure P.3 – DPLL timing 388
Figure Q.1 – PhL-P device connector r-a 390
Figure Q.2 – PhL-P device connector straight 391
Figure Q.3 – PhL-P flat cable connector and terminal cover – body and connector 391
Figure Q.4 – PhL-P flat cable connector and terminal cover – terminal cover 392
Figure Q.5 – Type 18-PhL-P round cable connector body 392
Figure Q.6 – Type 18-PhL-P round cable connector terminal cover 393
Figure Q.7 – Type 18-PhL-P round cable alternate connector and body 393
Figure Q.8 – Type 18-PhL-P round cable alternate connector terminal cover 394
Figure R.1 – PhL-B cable cross section twisted drain 395
Figure R.2 – PhL-B cable cross section non-twisted drain 396
Figure R.3 – PhL-P flat cable cross section - with key 397
Figure R.4 – PhL-P flat cable cross section - without key 397
Figure R.5 – PhL-P flat cable polarity marking 397
Figure R.6 – Round cable – preferred; cross section 398
Figure R.7 – Round cable – alternate; cross-section 398

Table 1 – Data encoding rules 60
Table 2 – Ph-STATUS indication truth table 61
Table 3 – Jabber indications 61
Table 4 – Parameter names and values for Ph-SET-VALUE request 78
Table 5 – Parameter names for Ph-EVENT indication 79
Table 6 – Summary of Ph-management services and primitives 80
Table 7 – Reset primitives and parameters 81
Table 8 – Values of PhM-Status for the Reset service 81
Table 9 – Set value primitives and parameters 82
Table 10 – Mandatory PhE-variables 82
Table 11 – Permissible values of PhE-variables 83
Table 12 – Values of PhM-Status for the set-value service 83
Table 13 – Get value primitives and parameters 83
Table 14 – Current values of PhE-variables 84
Table 15 – Values of PhM-Status for the get value service 84
Table 16 – Event primitive and parameters 84
Table 17 – New values of PhE-variables 85
Table 18 – Parameter names and values for management 85
Table 19 – PH-RESET 87
Table 20 – Ph-SET-VALUE 87
Table 21 – PhL variables 88
Table 22 – Ph-GET-VALUE 89
Table 23 – Ph-EVENT 90
Table 24 – PhL events 90
Table 25 – Parameter names and values for Ph-SET-VALUE request 91
Table 26 – Signals at DTE – DCE interface 95
Table 27 – Signal levels for an exposed DTE – DCE interface 96
Table 28 – MDS bus reset 106
Table 29 – Signals at the MIS-MDS interface 106
Table 30 – Manchester encoding rules 115
Table 31 – MDS timing characteristics 118
Table 32 – MDS data encoding rules 118
Table 33 – SL bit and TxSL signal assignment 125
Table 34 – SL bit and RxSL signal assignment 125
Table 35 – SL bit and TxSL signal assignment 126
Table 36 – SL bit and RxSL signal assignment 127
Table 37 – SL bit and TxSL signal assignment 127
Table 38 – SL bit and RxSL signal assignment 127
Table 39 – Coding and decoding rules 128
Table 40 – Decoding rules for the idle states 129
Table 41 – Coding rules for the reset PhPDU 129
Table 42 – Decoding rules of the reset PhPDU 129
Table 43 – Manchester encoding rules 132

Table 44 – Minimum services at MDS – MAU interface 135
Table 45 – Signal levels for an exposed MDS – MAU interface 136
Table 46 – MDS-MAU interface definitions: 5 Mbit/s, voltage-mode, coaxial wire 137
Table 47 – MDS-MAU interface 5 Mbit/s, optical fiber medium 138
Table 48 – Services of the MDS-MAU interface 140
Table 49 – Minimum services at MAU interface 142
Table 50 – Signal levels for an exposed MAU interface 142
Table 51 – Bit-rate-dependent quantities of voltage-mode networks 143
Table 52 – MAU transmit level specification summary 146
Table 53 – MAU transmit timing specification summary for 31,25 kbit/s operation 146
Table 54 – MAU transmit timing specification summary for ≥ 1 Mbit/s operation 147
Table 55 – MAU receive circuit specification summary 151
Table 56 – Network powered device characteristics 153
Table 57 – Network power supply requirements 153
Table 58 – Test cable attenuation limits 156
Table 59 – Recommended color coding of cables in North America 157
Table 60 – MAU transmit level specification summary 161
Table 61 – MAU transmit timing specification summary 161
Table 62 – MAU receive circuit specification summary 164
Table 63 – Network powered device characteristics 166
Table 64 – Network power supply requirements 166
Table 65 – Type 3 cable color specification 174
Table 66 – MAU transmit level specification summary 178
Table 67 – MAU transmit timing specification summary 178
Table 68 – Receive circuit specification summary 180
Table 69 – Network power supply requirements 182
Table 70 – Transmit level specification summary for current-mode MAU 188
Table 71 – Transmit timing specification summary for current-mode MAU 188
Table 72 – Receive circuit specification summary for current-mode MAU 190
Table 73 – Network power supply requirements 191
Table 74 – Bit-rate-dependent quantities of high-speed (≥1 Mbit/s) dual-fiber networks 194
Table 75 – Transmit level and spectral specification summary 196
Table 76 – Transmit timing specification summary 196
Table 77 – Receive circuit specification summary 197
Table 78 – Transmit and receive level and spectral specifications for an optical active star 200
Table 79 – Timing characteristics of an optical active star 201
Table 80 – Transmit level and spectral specification summary 202
Table 81 – Transmit and receive level and spectral specifications for an optical active star 204
Table 82 – Interfering frequencies for testing receiver performance 213
Table 83 – Transmit control line definitions 5 Mbit/s, voltage-mode, coaxial wire 216
Table 84 – Receiver data output definitions: 5 Mbit/s, voltage-mode, coaxial wire 217
Table 85 – Receiver carrier output definitions: 5 Mbit/s, voltage-mode, coaxial wire 217

Table 86 – Coaxial wire medium interface – transmit specifications 218
Table 87 – Coaxial wire medium interface – receive..... 219
Table 88 – Coaxial wire medium interface – general 220
Table 89 – 5 Mbit/s, voltage-mode, coaxial wire transformer electrical specifications 221
Table 90 – Coaxial spur cable specifications..... 225
Table 91 – Coaxial trunk cable specifications..... 225
Table 92 – Transmit control line definitions 5 Mbit/s, optical fiber medium 227
Table 93 – Fiber medium interface 5,0 Mbit/s, optical 227
Table 94 – Fiber signal specification 5 Mbit/s, optical medium, short range..... 228
Table 95 – Fiber signal specification 5 Mbit/s, optical medium, medium range 229
Table 96 – Fiber signal specification 5 Mbit/s, optical medium, long range..... 230
Table 97 – NAP requirements 232
Table 98 – Mixing devices from different categories..... 235
Table 99 – Input Impedances of bus interfaces and power supplies 238
Table 100 – Required CMRR 241
Table 101 – Network powered device characteristics for the 31,25 kbit/s voltage-mode MAU 241
Table 102 – Network power supply requirements for the 31,25 kbit/s voltage-mode MAU 242
Table 103 – Electrical characteristics of fieldbus interfaces 247
Table 104 – Electrical characteristics of power supplies..... 248
Table 105 – Characteristics for non intrinsic safety 252
Table 106 – Characteristics using repeaters 252
Table 107 – Cable specifications 254
Table 108 – Maximum cable length for the different transmission speeds 254
Table 109 – Characteristics for intrinsic safety..... 257
Table 110 – Cable specification (function- and safety-related) 260
Table 111 – Maximum cable length for the different transmission speeds 260
Table 112 – Electrical characteristics of the intrinsically safe interface 263
Table 113 – Maximum safety values 267
Table 114 – Characteristic features 268
Table 115 – Characteristics of optical transmitters for multi-mode glass fiber..... 271
Table 116 – Characteristics of optical transmitters for single-mode glass fiber..... 272
Table 117 – Characteristics of optical transmitters for plastic fiber..... 272
Table 118 – Characteristics of optical transmitters for 200/230 μm glass fiber 272
Table 119 – Characteristics of optical receivers for multi-mode glass fiber..... 273
Table 120 – Characteristics of optical receivers for single-mode glass fiber..... 273
Table 121 – Characteristics of optical receivers for plastic fiber..... 273
Table 122 – Characteristics of optical receivers for 200/230 μm glass fiber..... 274
Table 123 – Permissible signal distortion at the electrical input of the optical transmitter 274
Table 124 – Permissible signal distortion due to the optical transmitter..... 275
Table 125 – Permissible signal distortion due to the optical receiver..... 276

Table 126 – Permissible signal influence due to internal electronic circuits of a coupling component 276
Table 127 – Maximum chaining of standard optical links without retiming 277
Table 128 – Services of the MDS-MAU interface, RS-485, Type 4 278
Table 129 – Services of the MDS-MAU interface, RS-232, Type 4 280
Table 130 – Bit rate dependent quantities twisted pair wire medium MAU 281
Table 131 – Incoming interface signals 282
Table 132 – Outgoing interface signals 283
Table 133 – Remote bus cable characteristics 284
Table 134 – Bit rate dependent quantities optical MAU 286
Table 135 – Remote bus fiber optic cable length 287
Table 136 – Encoding rules 287
Table 137 – Transmit level and spectral specification summary for an optical MAU 287
Table 138 – Optical MAU receive circuit specification summary 289
Table 139 – Specification of the fiber optic waveguide 289
Table 140 – Specification of the single fiber 290
Table 141 – Specification of the cable sheath and mechanical properties of the cable 290
Table 142 – Recommended further material properties of the cable 290
Table 143 – Specification of the fiber optic waveguide 291
Table 144 – Specification of the single fiber 291
Table 145 – Specification of the cable sheath and mechanical properties of the cable 291
Table 146 – Specification of the standard test fiber for an optical MAU 292
Table 147 – Transmission rate support 297
Table 148 – Transmission data parameters 298
Table 149 – Possible slave input signals 300
Table 150 – Possible slave output signals 300
Table 151 – Valid slave output signals 301
Table 152 – Specifications of the clock adjustment times 301
Table 153 – Optical signal delay in a slave 301
Table 154 – Basic functions of the connection 302
Table 155 – Pass-through topology limits 309
Table 156 – T-branch topology limits 310
Table 157 – Terminating resistor requirements 310
Table 158 – Pass-through topology limits 314
Table 159 – T-branch topology limits 314
Table 160 – Terminating resistor requirements – flat cable 315
Table 161 – Terminating resistor requirements – round cable 315
Table 162 – 24 V Power supply specifications 316
Table 163 – 24V Power consumption specifications 317
Table A.1 – Internal connector dimensions 320
Table A.2 – Contact assignments for the external connector for harsh industrial environments 321
Table A.3 – Contact assignments for the external connector for typical industrial environments 325

Table A.4 – Fixed (device) side connector dimensions 325
Table A.5 – Free (cable) side connector dimensions 326
Table A.6 – Connector dimensions 327
Table B.1 – Typical cable specifications 328
Table B.2 – Recommended maximum spur lengths versus number of communication elements 329
Table C.1 – Optical passive star specification summary: example 330
Table D.1 – Passive star topology 332
Table D.2 – Active star topology 333
Table E.1 – Alternate fibers for dual-fiber mode 335
Table E.2 – Alternate fibers for single-fiber mode 335
Table F.1 – Connector requirements 336
Table F.2 – NAP connector pin definition 338
Table H.1 – 5 Mbit/s, voltage-mode, coaxial wire receiver output definitions 351
Table H.2 – Coaxial wire medium toroid specification 354
Table I.1 – Contact assignments for the external connector for harsh industrial environments 356
Table I.2 – Contact designations 358
Table I.3 – Contact designations 359
Table I.4 – Contact designations 359
Table K.1 – Example of a link budget calculation for 62,5/125 μm multi-mode glass fiber 370
Table K.2 – Example of a link budget calculation for 9/125 μm single mode glass fiber 371
Table K.3 – Example of a link budget calculation for 980/1 000 μm multi-mode plastic fiber 371
Table K.4 – Example of a level budget calculation for 200/230 μm multi-mode glass fiber 372
Table M.1 – Pin assignment of the 9-position subminiature D connector 375
Table M.2 – Pin assignment of the terminal connector 376
Table M.3 – Type 8 fiber optic hybrid connector dimensions 379
Table O.1 – Transmitter specifications 383
Table O.2 – Receiver specifications 383
Table O.3 – Cable specifications (example) 384
Table O.4 – System data of the optical transmission line at 650 nm 385
Table R.1 – PhL-B cable specifications 395
Table R.2 – PhL-P flat cable specifications 396
Table R.3 – PhL-P round cable specifications – preferred 397
Table R.4 – PhL-P round cable specifications – alternate 398

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 2: Physical layer specification and service definition

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.
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International Standard IEC 61158-2 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This fifth edition cancels and replaces the fourth edition published in 2007. This edition constitutes a technical revision.

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

- for Type 18, Table 157 reduced tolerance to 5%;
- for Type 18, in 32.5.3.1 removed minimum cable length;
- for Type 18, in 32.5.4. and R.2.2 cable reference removed;
- for Type 18, Table 160 and 161 terminating resistor value changed to 680 Ω.

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

FDIS	Report on voting
65C/598/FDIS	65C/613/RVD

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

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

NOTE Slight variances from the directives have been allowed by the IEC Central Office to provide continuity of subclause numbering with prior editions.

The 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 website.

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 '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.

0 Introduction

0.1 General

This part of IEC 61158 is one of a series produced to facilitate the interconnection of automation system components. It is related to other standards in the set as defined by the "three-layer" fieldbus reference model described in IEC/TR 61158-1.

0.2 Physical layer overview

The primary aim of this standard is to provide a set of rules for communication expressed in terms of the procedures to be carried out by peer Ph-entities at the time of communication.

The physical layer receives data units from the data-link Layer, encodes them, if necessary by adding communications framing information, and transmits the resulting physical signals to the transmission medium at one node. Signals are then received at one or more other node(s), decoded, if necessary by removing the communications framing information, before the data units are passed to the data-link Layer of the receiving device.

0.3 Document overview

This standard comprises physical layer specifications corresponding to many of the different DL-Layer protocol Types specified in IEC 61158-4-1 to IEC 61158-4-18.

NOTE 1 The protocol Type numbers used are consistent throughout the IEC 61158 series.

NOTE 2 Specifications for Types 1, 2, 3, 4, 8, 16 and 18 are included. Type 7 uses Type 1 specifications. The other Types do not use any of the specifications given in this standard.

NOTE 3 For ease of reference, Type numbers are given in clause names. This means that the specification given therein applies to this Type, but does not exclude its use for other Types.

NOTE 4 It is up to the user of this standard to select interoperating sets of provisions. Refer to the IEC 61784 series for standardized communication profiles based on the IEC 61158 series.

A general model of the physical layer is shown in Figure 1.

The common characteristics for all variants and types are as follows:

– digital data transmission;
– no separate clock transmission;
– either half-duplex communication (bi-directional but in only one direction at a time) or full-duplex communication.

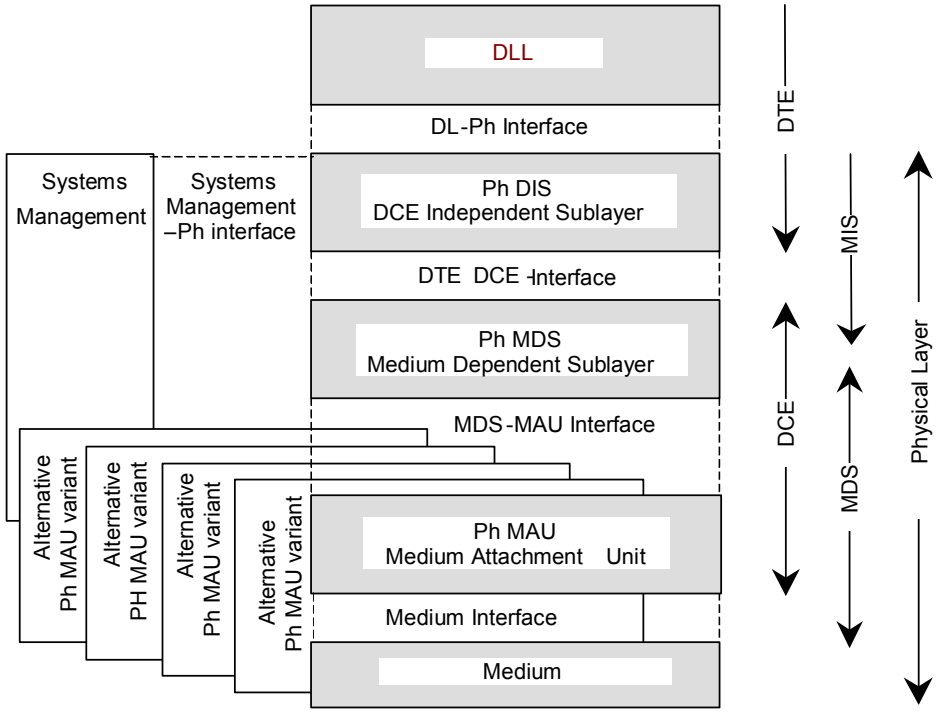

Figure 1 – General model of physical layer

NOTE 5 The protocol types use a subset of the structure elements.

NOTE 6 Since Type 8 uses a more complex DIS than the other types, it uses the term MIS to differentiate.

0.4 Major physical layer variations specified in this standard

0.4.1 Type 1 media

0.4.1.1 Type 1: Wire media

For twisted-pair wire media, Type 1 specifies two modes of coupling and different signaling speeds as follows:

a) voltage mode (parallel coupling), 150 Ω, data rates from 31,25 kbit/s to 25 Mbit/s;

b) voltage mode (parallel coupling), 100 Ω, 31,25 kbit/s;

c) current mode (serial coupling), 1,0 Mbit/s including two current options.

The voltage mode variations may be implemented with inductive coupling using transformers. This is not mandatory if the isolation requirements of this standard are met by other means.

The Type 1 twisted-pair (or untwisted-pair) wire medium physical layer provides the options:

– no power via the bus conductors; not intrinsically safe;
– power via the bus conductors; not intrinsically safe;
– no power via the bus conductors; intrinsically safe;
– power via the bus conductors; intrinsically safe.

0.4.1.2 Type 1: Optical media

The major variations of the Type 1 optic fiber media are as follows:

– dual fiber mode, data rates from 31,25 kbit/s to 25 Mbit/s;
– single fiber mode, 31,25 kbit/s.

0.4.1.3 Type 1: Radio media

The Type 1 radio medium specification provides a generalized FSK/PSK radio capability at arbitrary bit rates.

0.4.2 Type 2: Coaxial wire and optical media

Type 2 specifies the following variants:

– coaxial copper wire medium, 5 Mbit/s;
– optical fiber medium, 5 Mbit/s;
– network access port (NAP), a point-to-point temporary attachment mechanism that can be used for programming, configuration, diagnostics or other purposes;
– repeater machine sublayers (RM, RRM) and redundant physical layers.

0.4.3 Type 3: Twisted-pair wire and optical media

Type 3 specifies the following synchronous transmission:

a) twisted-pair wire medium, 31,25 kbit/s, voltage mode (parallel coupling) with the options:
   – power via the bus conductors: not intrinsically safe;
   – power via the bus conductors: intrinsically safe;

   and the following asynchronous transmission variants:

b) twisted-pair wire medium, up to 12 Mbit/s, ANSI TIA/EIA-485-A;
c) optical fiber medium, up to 12 Mbit/s.

0.4.4 Type 4: Wire medium

Type 4 specifies wire media with the following characteristics:

– RS-485 wire medium up to 76,8 kbit/s;
– RS-232 wire medium up to 230,4 kbit/s.

0.4.5 Type 8: Twisted-pair wire and optical media

The physical layer also allows transmitting data units that have been received through a medium access by the transmission medium directly through another medium access and its transmission protocol to another device.

Type 8 specifies the following variants:

– twisted-pair wire medium, up to 16 Mbit/s;
– optical fiber medium, up to 16 Mbit/s.

The general characteristics of these transmission media are as follows:

– full-duplex transmission;
– non-return-to-zero (NRZ) coding.

The wire media type provides the following options:

– no power supply via the bus cable, not intrinsically safe;
– power supply via the bus cable and on additional conductors, not intrinsically safe.

0.4.6 Type 12: Wire medium

Type 12 specifies wire media with the following characteristics:

– LVDS wire medium up 100 Mbit/s.

0.4.7 Type 16: optical media

Type 16 specifies a synchronous transmission using optical fiber medium, at 2 Mbit/s, 4 Mbit/s, 8 Mbit/s and 16 Mbit/s.

0.4.8 Type 18: Media

0.4.8.1 Type 18: Basic media

The Type 18-PhL-B specifies a balanced transmission signal over a shielded 3-core twisted cable. Communication data rates as high as 10 Mbit/s and transmission distances as great as 1,2 km are specified.

0.4.8.2 Type 18: Powered media

The Type 18-PhL-P specifies a balanced transmission signal over a 4-core unshielded cable in both flat and round configurations with conductors specified for communications signal and network-embedded power distribution. Communication data rates as high as 2,5 Mbit/s and transmission distances as great as 500 m are specified.

0.5 Patent declaration

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

Use of some of the associated protocol types is restricted by their intellectual-property-right holders. In all cases, the commitment to limited release of intellectual-property-rights made by the holders of those rights permits a particular data-link layer protocol type to be used with physical layer and application layer protocols in type combinations as specified explicitly in the IEC 61784 series. Use of the various protocol types in other combinations may require permission of their respective intellectual-property-right holders.

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 2 given in subclauses 5.3, 9.4, 10.4, Clauses 18 through 20, Annex F through Annex H, as follows:

US 5,396,197 Network Node TAP

IEC takes no position concerning the evidence, validity and scope of this patent right.

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

Rockwell Automation, Inc.
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USA
Attention: Intellectual Property Dept.

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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 2: Physical layer specification and service definition

1 Scope

This part of IEC 61158 specifies the requirements for fieldbus component parts. It also specifies the media and network configuration requirements necessary to ensure agreed levels of

a) data integrity before data-link layer error checking;

b) interoperability between devices at the physical layer.

The fieldbus physical layer conforms to layer 1 of the OSI 7-layer model as defined by ISO 7498 with the exception that, for some types, frame delimiters are in the physical layer while for other types they are in the data-link layer.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-731, *International Electrotechnical Vocabulary – Chapter 731: Optical fibre communication*

IEC 60079-11, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"*

IEC 60079-14:2002[1], *Electrical apparatus for explosive gas atmospheres – Part 14: Electrical installations in hazardous areas (other than mines)*

IEC 60079-25, *Electrical apparatus for explosive gas atmospheres – Part 25: Intrinsically safe systems*

IEC 60169-17:1980, *Radio-frequency connectors – Part 17: R.F. coaxial connectors with inner diameter of outer conductor 6,5 mm (0,256 in) with screw coupling – Characteristic impedance 50 ohms (Type TNC)*
Amendment 1 (1993)

IEC 60189-1:2007, *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 1: General test and measuring methods*

IEC 60255-22-1:1988[2], *Electrical relays – Part 22-1: Electrical disturbance tests for measuring relays and protection equipment – 1 MHz burst disturbance tests*

IEC 60364-4-41, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

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1 There exists a new edition of IEC 60079-14 (2007). This will be considered in the next edition of IEC 61158-2.

2 There exists a new edition of IEC 60255-22-1 (2007). This will be considered in the next edition of IEC 61158-2.

IEC 60364-5-54, *Electrical installations of buildings – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements, protective conductors and protective bonding conductors*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60603-7-4, *Connectors for electronic equipment – Part 7-4: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*

IEC 60760, *Flat, quick-connect terminations*

IEC 60793 (all parts), *Optical fibres*

IEC 60794-1-2:2003, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures*

IEC 60807-3, *Rectangular connectors for frequencies below 3 MHz – Part 3: Detail specification for a range of connectors with trapezoidal shaped metal shells and round contacts – Removable crimp contact types with closed crimp barrels, rear insertion/rear extraction*

IEC 60874-10-1, *Connectors for optical fibres and cables – Part 10-1: Detail specification for fiber optic connector type BFOC/2,5 terminated to multimode fibre type A1*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques — Electrostatic discharge immunity test* (Basic EMC Publication)

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques — Radiated, radio-frequency, electromagnetic field immunity test* (Basic EMC Publication)

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 44: Testing and measurement techniques — Electrical fast transient/burst immunity test* (Basic EMC Publication)

IEC 61131-2, *Programmable controllers – Part 2: Equipment requirements and tests*

IEC 61156-1:2007, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

IEC 61158-4-2, *Industrial communication network – Fieldbus specifications – Part 4-2: Data-link protocol specification – Type 2 elements*

IEC 61158-4-3:2010[3], *Industrial communication network – Fieldbus specifications – Part 4-3: Data-link protocol specification – Type 3 elements*

IEC 61169-8:2007, *Radio-frequency connectors – Part 8: Sectional specification – RF coaxial connectors with inner diameter of outer conductor 6,5 mm (0,256 in) with bayonet lock – Characteristic impedance 50 Ω (type BNC)*

IEC 61754-2, *Fibre optic connector interfaces – Part 2: Type BFOC/2,5 connector family*

IEC 61754-13, *Fibre optic connector interfaces – Part 13: Type FC-PC connector*

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[3] To be published.

IEC 61754-22, *Fibre optic connector interfaces – Part 22: Type F-SMA connector family*

ISO/IEC 7498 (all parts), *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

ISO/IEC 8482, *Information technology – Telecommunications and information exchange between systems – Twisted pair multipoint interconnections*

ISO/IEC 8802-3, *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*

ISO/IEC 9314-1, *Information processing systems – Fibre distributed data interface (FDDI) Part 1: Token Ring Physical Layer Protocol (PHY)*

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

ANSI TIA/EIA-232-F, *Interface Between Data Terminal Equipment and Data Circuit – Terminating Equipment Employing Serial Binary Data Interchange*

ANSI TIA/EIA-422-B, *Electrical Characteristics of Balanced Voltage Digital Interface Circuits*

ANSI TIA/EIA-485-A, *Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems*

ANSI TIA/EIA-644-A, *Electrical Characteristics of Low Voltage Differential Signaling (LVDS) Interface Circuits*