

# INTERNATIONAL STANDARD

IEC  
**61158-2**

Third edition  
2003-05

**Digital data communications  
for measurement and control –  
Fieldbus for use in industrial  
control systems –**

**Part 2: Physical layer specification  
and service definition**

<https://standards.iteh.ai/0015g/standards/iec/260c465e-3e2e-4cb2-8b6a-8e7776e975a7/iec-61158-2-2003>



Reference number  
IEC 61158-2:2003(E)

## Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

## Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

## Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

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

The on-line catalogue on the IEC web site ([http://www.iec.ch/searchpub/cur\\_fut.htm](http://www.iec.ch/searchpub/cur_fut.htm)) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

This summary of recently issued publications ([http://www.iec.ch/online\\_news/justpub/jp\\_entry.htm](http://www.iec.ch/online_news/justpub/jp_entry.htm)) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

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

# INTERNATIONAL STANDARD

IEC  
**61158-2**

Third edition  
2003-05

**Digital data communications  
for measurement and control –  
Fieldbus for use in industrial  
control systems –**

**Part 2: Physical layer specification  
and service definition**

<https://standards.iteh.ai/standard/standards/iec/360c465e-3e2e-4cb2-8b6a-8e7776e975a7/iec-61158-2-2003>



© IEC 2003 – Copyright - all rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland  
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: [inmail@iec.ch](mailto:inmail@iec.ch) Web: [www.iec.ch](http://www.iec.ch)



Commission Electrotechnique Internationale  
International Electrotechnical Commission  
Международная Электротехническая Комиссия

PRICE CODE

XH

*For price, see current catalogue*

## CONTENTS

FOREWORD .....	12
Introduction .....	15
1 Scope .....	19
2 Normative references .....	20
3 Terms and definitions .....	22
3.1 Common terms and definitions .....	22
3.2 Type 1: Terms and definitions .....	26
3.3 Type 2: Terms and definitions .....	27
3.4 Type 3: Terms and definitions .....	30
3.5 Type 4: Terms and definitions .....	31
3.6 Type 6: Terms and definitions .....	31
3.7 Type 8: Terms and definitions .....	32
4 Symbols and abbreviations .....	35
4.1 Symbols .....	35
4.2 Abbreviations .....	37
5 DLL – PhL interface .....	44
5.1 General .....	44
5.2 Type 1: Required services .....	44
5.3 Type 2: Required services .....	46
5.4 Type 3: Required services .....	49
5.5 Type 4: Required services .....	50
5.6 Type 6: Required services .....	52
5.7 Type 8: Required services .....	54
6 Systems management – PhL interface .....	62
6.1 General .....	62
6.2 Type 1: Systems management – PhL interface .....	62
6.3 Type 3: Systems management – PhL interface .....	64
6.4 Type 4: Systems management – PhL interface .....	69
6.5 Type 6: Systems management – PhL interface .....	70
6.6 Type 8: Systems management – PhL interface .....	71
7 DCE Independent Sublayer (DIS) .....	76
7.1 General .....	76
7.2 Type 1: DIS .....	76
7.3 Type 3: DIS .....	76
7.4 Type 6: DIS .....	76
7.5 Type 8: DIS .....	77
8 DTE – DCE interface and MIS-specific functions .....	79
8.1 General .....	79
8.2 Type 1: DTE – DCE interface .....	79
8.3 Type 3: DTE – DCE interface .....	89
8.4 Type 8: MIS – MDS Interface .....	90
9 Medium Dependent Sublayer (MDS) .....	100
9.1 General .....	100
9.2 Type 1: MDS: Wire and optical media .....	100
9.3 Type 1: MDS: Low speed radio medium .....	104

9.4	Type 2: MDS: Wire and optical media .....	109
9.5	Type 3: MDS: Wire and optical media .....	110
9.6	Type 4: MDS: Wire medium .....	110
9.7	Type 6: MDS: Wire and optical media .....	114
9.8	Type 8: MDS: Wire and optical media .....	118
10	MDS – MAU interface.....	126
10.1	General .....	126
10.2	Type 1: MDS – MAU interface: wire and optical media .....	126
10.3	Type 1: MDS – MAU interface: Low speed radio medium .....	128
10.4	Type 2: MDS – MAU interface: Wire and optical media .....	129
10.5	Type 3: MDS – MAU interface: Wire and optical media .....	132
10.6	Type 8: MDS – MAU interface: Wire and optical media .....	132
11	Types 1 and 7: Medium Attachment Unit: voltage mode, linear-bus-topology 150 Ω twisted-pair wire medium.....	135
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 .....	150
13	Type 1: Medium Attachment Unit: current mode, twisted-pair wire medium .....	168
14	Type 1: Medium Attachment Unit: current mode (1 A), twisted-pair wire medium .....	179
15	Types 1 and 7: Medium Attachment Unit: dual-fibre optical media .....	188
16	Type 1: Medium Attachment Unit: 31,25 kbit/s, single-fibre optical medium .....	195
17	Type 1: Medium Attachment Unit: low speed radio medium .....	198
18	Type 2: Medium Attachment Unit: 5 Mbit/s, voltage-mode, coaxial wire medium.....	207
19	Type 2: Medium Attachment Unit: 5 Mbit/s, optical medium .....	219
20	Type 2: Medium Attachment Unit: Network Access Port (NAP).....	223
21	Type 3: Medium Attachment Unit: Synchronous transmission, 31,25 kbit/s, voltage mode, wire medium .....	227
22	Type 3: Medium Attachment Unit: Asynchronous Transmission, wire medium .....	236
23	Type 3: Medium Attachment Unit: Asynchronous Transmission, optical medium .....	242
24	Type 4: Medium Attachment Unit: RS-485.....	252
25	Type 4: Medium Attachment Unit: RS-232.....	254
26	Type 6: Medium Attachment Unit: RS-485.....	255
27	Type 8: Medium Attachment Unit: twisted-pair wire medium .....	261
28	Type 8: Medium Attachment Unit: Optical media .....	266
	Annex A (normative) — Type 1: Connector specification .....	273
A.1	Internal connector for wire medium .....	273
A.2	External connectors for wire medium .....	273
A.3	External connectors for optical medium .....	279
	Annex B (informative) — Types 1 and 3: Cable specifications and trunk and spur lengths for the 31,25 kbit/s voltage-mode MAU.....	281
	Annex C (informative) — Types 1 and 7: Optical passive stars .....	283
	Annex D (informative) — Types 1 and 7: Star topology .....	284
	Annex E (informative) — Type 1: Alternate fibres.....	288
E.1	Alternate fibres for dual-fibre mode .....	288
E.2	Alternate fibres for single-fibre mode .....	288
	Annex F (normative) — Type 2: Connector specification .....	289
F.1	Connector for coaxial wire medium .....	289

F.2	Connector for optical medium .....	289
F.3	Connector for NAP medium .....	290
Annex G (normative) — Type 2: Repeater machine sublayers (RM, RRM) and redundant PhLs.....	292	
G.2	Repeater Machine (RM) sublayer.....	293
G.3	Redundant PhL.....	295
G.4	Ring Repeater Machine (RRM) sublayer .....	296
Annex H (informative) — Type 2: Reference design examples .....	303	
H.1	MAU: 5 Mbit/s, voltage mode, coaxial wire .....	303
H.2	Network Access Port.....	307
Annex I (normative) — Type 3: Connector specification .....	309	
I.1	Connector for synchronous transmission.....	309
I.2	Connector for asynchronous transmission.....	310
I.3	Connectors for fibre optic cable .....	311
Annex J (normative) — Type 3: Redundancy of PhL and Medium .....	312	
Annex K (normative) — Type 3: Optical network topology.....	313	
Annex L (normative) — Type 6: Connector specification .....	322	
Annex M (normative) — Type 8: Connector specification .....	324	
M.1	External Connectors for wire medium .....	324
M.2	External connectors for fibre optic medium .....	325

Figure 1 – Relationship of IEC 61158-2 to other fieldbus layers and to users of the fieldbus Physical layer service ..... 15

Figure 2 – General model of Physical Layer ..... 16

Figure 3 – Mapping between data units across the DLL – PhL interface ..... 44

Figure 4 – Data service for asynchronous transmission..... 49

<https://www.iec.ch/61158-2-1-2003.pdf>

Figure 5 – Interactions for a data sequence of a master: identification cycle ..... 56

Figure 6 – Interactions for a data sequence of a master: data cycle ..... 57

Figure 7 – Interactions for a data sequence of a slave: identification cycle ..... 58

Figure 8 – Interactions for a data sequence of a slave: data cycle ..... 59

Figure 9 – Interactions for a check sequence of a master ..... 60

Figure 10 – Interactions for a check sequence of a slave ..... 61

Figure 11 – Reset, Set Value, Get Value ..... 65

Figure 12 – Event service ..... 66

Figure 13 – Interface between PhL and PNM1 in the layer model..... 71

Figure 14 – Reset, Set Value, Get Value PhL services..... 72

Figure 15 – Event PhL service ..... 73

Figure 16 – Allocation of the interface number ..... 74

Figure 17 – Configuration of a master ..... 78

Figure 18 – Configuration of a slave with an alternative type of transmission ..... 78

Figure 19 – Configuration of a bus coupler with an alternative type of transmission ..... 78

Figure 20 – DTE/DCE sequencing machines..... 83

Figure 21 – State transitions with the ID cycle request service..... 92

Figure 22 – MIS-MDS interface: identification cycle request service..... 93

Figure 23 – MIS-MDS interface: identification cycle request service..... 94

Figure 24 – State transitions with the data cycle request service..... 94

Figure 25 – MIS-MDS interface: data cycle request service.....	95
Figure 26 – State transitions with the data sequence classification service .....	95
Figure 27 – Protocol machine for the message transmission service .....	96
Figure 28 – Protocol machine for the data sequence identification service .....	97
Figure 29 – Protocol machine for the message receipt service.....	98
Figure 30 – Protocol Data Unit (PhPDU) .....	100
Figure 31 – PhSDU encoding and decoding .....	100
Figure 32 – Manchester encoding rules .....	101
Figure 33 – Preamble and delimiters.....	102
Figure 34 – General model of the PhL with the low speed radio medium.....	104
Figure 35 – Radio medium fieldbus code frames and radio Physical Data Units for all but the last code frame of a corresponding PhSDU sequence .....	105
Figure 36 – Radio medium fieldbus code frame.....	105
Figure 37 – Radio medium fieldbus forward error correction octets 1 and 2.....	106
Figure 38 – Radio medium fieldbus code frames and radio Physical Data Units example of last code frame of a PhSDU sequence encoding .....	106
Figure 39 – Manchester coded symbols .....	110
Figure 40 – PhPDU format, half duplex .....	111
Figure 41 – PhPDU format, full duplex .....	113
Figure 42 – PhPDU.....	115
Figure 43 – Ph-slot .....	115
Figure 44 – Preamble, Start delimiter and PAD .....	117
Figure 45 – End Transfer Frame, Bus Sync and End of Data delimiters, with Strobes .....	118
Figure 46 – Data sequence PhPDU.....	119
Figure 47 – Structure of the header in a data sequence PhPDU.....	119
Figure 48 – Check sequence PhPDU .....	120
Figure 49 – Structure of a headers in a check sequence PhPDU.....	120
Figure 50 – Structure of the status PhPDU.....	121
Figure 51 – Structure of the header in a status PhPDU .....	121
Figure 52 – Structure of the medium activity status PhPDU.....	122
Figure 53 – Structure of the header in a medium activity status PhPDU .....	122
Figure 54 – Reset PhPDU .....	123
Figure 55 – Configuration of a master .....	124
Figure 56 – Configuration of a slave .....	125
Figure 57 – Configuration of a bus coupler.....	125
Figure 58 – Jitter tolerance .....	134
Figure 59 – Transmit circuit test configuration.....	139
Figure 60 – Output waveform.....	139
Figure 61 – Transmitted and received bit cell jitter (zero crossing point deviation)	140
Figure 62 – Signal polarity .....	142
Figure 63 – Receiver sensitivity and noise rejection .....	143
Figure 64 – Power supply ripple and noise.....	146
Figure 65 – Fieldbus coupler.....	148
Figure 66 – Transition from receiving to transmitting .....	155
Figure 67 – Power supply ripple and noise.....	159
Figure 68 – Test circuit for single-output power supplies.....	160

Figure 69 – Test circuit for power distribution through an IS barrier .....	161
Figure 70 – Test circuit for multiple output supplies with signal coupling .....	162
Figure 71 – Fieldbus coupler.....	164
Figure 72 – Protection resistors .....	165
Figure 73 – Test configuration for current-mode MAU .....	171
Figure 74 – Transmitted and received bit cell jitter (zero crossing point deviation) .....	172
Figure 75 – Noise test circuit for current-mode MAU .....	174
Figure 76 – Transmitted and received bit cell jitter (zero crossing point deviation) .....	183
Figure 77 – Power supply harmonic distortion and noise.....	185
Figure 78 – Optical wave shape template.....	190
Figure 79 – Cellular radio topology and reuse of frequencies .....	199
Figure 80 – Radio segment between wired segments topology.....	200
Figure 81 – Mixed wired and radio medium fieldbus topology.....	201
Figure 82 – Gaussian Minimum Shift Keying modulation with $B_n = 0.41$ .....	203
Figure 83 – Radio envelope using GMSK.....	203
Figure 84 – Components of 5 Mbit/s, voltage-mode, coaxial wire PHL variant .....	207
Figure 85 – Coaxial wire MAU block diagram .....	208
Figure 86 – Coaxial wire MAU transmitter .....	208
Figure 87 – Coaxial wire MAU receiver operation.....	209
Figure 88 – Coaxial wire MAU transmit mask .....	210
Figure 89 – Coaxial wire MAU receive mask .....	211
Figure 90 – Transformer symbol .....	212
Figure 91 – 5Mbit/s, voltage-mode, coaxial wire topology example .....	214
Figure 92 – Coaxial wire medium topology limits .....	215
Figure 93 – Coaxial wire medium tap electrical characteristics.....	216
Figure 94 – MAU block diagram 5 Mbit/s, optical fibre medium .....	219
Figure 95 – NAP reference model .....	223
Figure 96 – Example of transient and permanent nodes.....	224
Figure 97 – NAP transceiver .....	225
Figure 98 – NAP cable .....	226
Figure 99 – Power supply ripple and noise.....	232
Figure 100 – Repeater in linear bus topology .....	237
Figure 101 – Repeater in tree topology .....	237
Figure 102 – Example for a connector with integrated inductance .....	239
Figure 103 – Interconnecting wiring .....	239
Figure 104 – Bus Terminator.....	240
Figure 105 – Connection to the optical network.....	242
Figure 106 – Principle structure of optical networking .....	243
Figure 107 – Definition of the standard optical link .....	244
Figure 108 – Signal template for the optical transmitter.....	249
Figure 109 – Recommended interface circuit .....	253
Figure 110 – Minimum interconnecting wiring.....	256
Figure 111 – RS-485 Ph—segment termination network .....	257
Figure 112 – Example for a connector with integrated inductance .....	258
Figure 113 – Maximum single Ph-segment bus topology .....	259
Figure 114 – Example maximum linear bus topology with four Ph-segments .....	260

Figure 115 – Example star topology with six Ph-segments .....	260
Figure 116 – MAU of an outgoing interface .....	261
Figure 117 – MAU of an incoming interface.....	261
Figure 118 – Remote bus link .....	262
Figure 119 – Interface to the transmission medium .....	262
Figure 120 – Wiring .....	265
Figure 121 – Terminal resistor network .....	265
Figure 122 – Fibre optic remote bus cable .....	266
Figure 123 – Optical fibre remote bus link .....	267
Figure 124 – Optical wave shape template optical MAU .....	268
Figure A.1 – Internal fieldbus connector.....	273
Figure A.2 – Contact designations for the external connector for harsh industrial environments	275
Figure A.3 – External fieldbus connector keyways, keys, and bayonet pins and grooves.....	275
Figure A.4 – External fieldbus connector intermateability dimensions.....	276
Figure A.5 – External fieldbus connector contact arrangement.....	277
Figure A.6 – Contact designations for the external connector for typical industrial environments .....	278
Figure A.7 – External fixed (device) side connector for typical industrial environments: dimensions .....	278
Figure A.8 – External free (cable) side connector for typical industrial environments: dimensions .....	279
Figure A.9 – Optical connector for typical industrial environments (FC connector) .....	279
Figure A.10 – Optical connector for typical industrial environments (ST connector).....	280
Figure C.1 – Example of an optical passive reflective star.....	283
Figure C.2 – Example of an optical passive transmissive star.....	283
Figure D.1 – Example of star topology with 31,25 kbit/s, single fibre mode, optical MAU.....	284
Figure D.2 – Multi-star topology with an optical MAU .....	284
Figure D.3 – Example of mixture between wire and optical media for a 31,25 kbit/s bit rate	286
Figure D.4 – Example of mixture between wire and optical media .....	287
Figure F.1 – Pin connector for short range optical medium.....	290
Figure F.2 – Crimp ring for short range optical medium .....	290
Figure G.1 – PhL repeater device reference model .....	293
Figure G.2 – Reference model for redundancy .....	295
Figure G.3 – Block diagram showing redundant coaxial medium and NAP .....	296
Figure G.4 – Block diagram showing ring repeaters .....	297
Figure G.5 – Segmentation query .....	298
Figure G.6 – Segmentation response .....	298
Figure G.7 – Main switch state machine.....	300
Figure G.8 – Port 1 sees network activity first.....	301
Figure G.9 – Port 2 sees network activity first.....	302
Figure H.1 – Coaxial wire MAU RxDATA detector .....	304
Figure H.2 – Coaxial wire MAU RxCARRIER detection.....	305
Figure H.3 – Redundant coaxial wire MAU transceiver.....	305
Figure H.4 – Single channel coaxial wire MAU transceiver.....	306
Figure H.5 – Coaxial wire medium tap.....	307
Figure H.6 – Non-isolated NAP transceiver.....	308
Figure H.7 – Isolated NAP transceiver .....	308

Figure I.1 – Schematic of the station coupler .....	309
Figure I.2 – Pin assignment of the male and female connectors IEC 947-5-2 (A coding) ....	310
Figure I.3 – Connector pinout, front view of male and back view of female respectively .....	311
Figure J.1 – Redundancy of PhL's MAU and Medium .....	312
Figure K.1 – Optical MAU in a network with echo .....	313
Figure K.2 – Optical MAU in a network without echo .....	314
Figure K.3 – Optical MAU with echo via internal electrical feedback of the receive signal ...	314
Figure K.4 – Optical MAU without echo function.....	315
Figure K.5 – Optical network with star topology.....	315
Figure K.6 – Optical network with ring topology.....	316
Figure K.7 – Optical network with bus topology.....	316
Figure K.8 – Tree structure built from a combination of star structures.....	317
Figure K.9 – Application example for an ANSI TIA/EIA-485-A / fibre optic converter .....	318
Figure L.1 – 9 pin subminiature D Connector pinout.....	322
Figure M.1 – Outgoing interface 9-position female subminiature D connector at the device.	324
Figure M.2 – Incoming interface 9-position male subminiature D connector at the device....	324
Figure M.3 – Terminal connector at the device.....	325
Figure M.4 – Ferrule of an optical F-SMA connector for polymer optical fibre (980/1000 µm) .....	325
 iTeh Standards Review <a href="https://www.iteh.ai">https://www.iteh.ai</a>	
Table 1 – Data encoding rules .....	47
Table 2 – Ph-STATUS indication truth table .....	48
Table 3 – Jabber indications .....	48
Table 4 – Parameter names and values for Ph-SET-VALUE request .....	63
Table 5 – Parameter names for Ph-EVENT Indication .....	64
Table 6 – Summary of Ph-management services and primitives .....	65
Table 7 – Reset primitives and parameters .....	66
Table 8 – Values of PhM-Status for the Reset service.....	66
Table 9 – Set value primitives and parameters .....	67
Table 10 – Mandatory PhE-variables .....	67
Table 11 – Permissible values of PhE-variables.....	67
Table 12 – Values of PhM-Status for the set-value service.....	68
Table 13 – Get value primitives and parameters .....	68
Table 14 – Current values of PhE-variables .....	68
Table 15 – Values of PhM-Status for the get value service.....	69
Table 16 – Event primitive and parameters .....	69
Table 17 – New values of PhE-variables .....	69
Table 18 – Parameter names and values for management .....	70
Table 19 – Parameter names and values for Ph-SET-VALUE request.....	70
Table 20 – PH-RESET .....	73
Table 21 – Ph-SET-VALUE.....	73
Table 22 – PhL variables .....	73
Table 23 – Ph-GET-VALUE .....	75
Table 24 – Ph-EVENT .....	75
Table 25 – PhL events .....	75
Table 26 – Signals at DTE – DCE interface.....	80
Table 27 – Signal levels for an exposed DTE – DCE interface .....	81
Table 28 – MDS Bus Reset.....	91

Table 29 – Signals at the MIS-MDS interface .....	91
Table 30 – Manchester encoding rules.....	101
Table 31 – Length and end of PhSDU sequence code.....	107
Table 32 – MDS timing characteristics .....	109
Table 33 – MDS data encoding rules .....	110
Table 34 – SL bit and TxSL signal assignment .....	120
Table 35 – SL bit and RxSL signal assignment .....	120
Table 36 – SL bit and TxSL signal assignment.....	121
Table 37 – SL bit and RxSL signal assignment .....	121
Table 38 – SL bit and TxSL signal assignment.....	122
Table 39 – SL bit and RxSL signal assignment .....	122
Table 40 – Coding and decoding rules .....	123
Table 41 – Decoding rules for the idle states .....	123
Table 42 – Coding rules for the reset PhPDU .....	124
Table 43 – Decoding rules of the reset PhPDU .....	124
Table 44 – Minimum services at MDS – MAU interface .....	126
Table 45 – Signal levels for an exposed MDS – MAU interface .....	127
Table 46 – Minimum services at MDS – MAU interface .....	128
Table 47 – Signal levels for an exposed MDS – MAU interface .....	129
Table 48 – MDS-MAU interface definitions: 5 Mbit/s, voltage-mode, coaxial wire .....	130
Table 49 – MDS-MAU interface 5 Mbit/s, optical fibre medium .....	131
Table 50 – Services of the MDS-MAU interface .....	132
Table 51 – Bit-rate-dependent quantities of voltage-mode networks.....	135
Table 52 – MAU transmit level specification summary .....	138
Table 53 – MAU transmit timing specification summary for 31,25 kbit/s operation .....	138
Table 54 – MAU transmit timing specification summary for $\geq 1$ Mbit/s operation.....	138
Table 55 – MAU receive circuit specification summary .....	142
Table 56 – Network powered device characteristics .....	145
Table 57 – Network power supply requirements .....	145
Table 58 – Test cable attenuation limits .....	147
Table 59 – Recommended colour coding of cables in North America.....	149
Table 60 – MAU transmit level specification summary .....	153
Table 61 – MAU transmit timing specification summary .....	153
Table 62 – MAU receive circuit specification summary .....	156
Table 63 – Network powered device characteristics .....	158
Table 64 – Network power supply requirements .....	158
Table 65 – Type 3 cable colour specification.....	166
Table 66 – MAU transmit level specification summary .....	170
Table 67 – MAU transmit timing specification summary .....	171
Table 68 – Receive circuit specification summary .....	173
Table 69 – Network power supply requirements .....	175
Table 70 – Transmit level specification summary for current-mode MAU .....	182
Table 71 – Transmit timing specification summary for current-mode MAU .....	182
Table 72 – Receive circuit specification summary for current-mode MAU .....	184
Table 73 – Network power supply requirements .....	185
Table 74 – Bit-rate-dependent quantities of high-speed ( $\geq 1$ Mbit/s) dual-fibre networks .....	188
Table 75 – Transmit level and spectral specification summary .....	190
Table 76 – Transmit timing specification summary .....	190
Table 77 – Receive circuit specification summary .....	191

Table 78 – Transmit and receive level and spectral specifications for an optical active star	194
Table 79 – Timing characteristics of an optical active star.....	194
Table 80 – Transmit level and spectral specification summary .....	196
Table 81 – Transmit and receive level and spectral specifications for an optical active star	197
Table 82 – Interfering frequencies for testing receiver performance .....	206
Table 83 – Transmit control line definitions 5 Mbit/s, voltage-mode, coaxial wire .....	208
Table 84 – Receiver data output definitions: 5 Mbit/s, voltage-mode, coaxial wire .....	209
Table 85 – Receiver carrier output definitions: 5 Mbit/s, voltage-mode, coaxial wire.....	209
Table 86 – Coaxial wire medium interface – transmit specifications .....	210
Table 87 – Coaxial wire medium interface – receive.....	211
Table 88 – Coaxial wire medium interface – general .....	212
Table 89 – 5 Mbit/s, voltage-mode, coaxial wire transformer electrical specifications .....	213
Table 90 – Coaxial spur cable specifications.....	217
Table 91 – Coaxial trunk cable specifications.....	218
Table 92 – Transmit control line definitions 5 Mbit/s, optical fibre medium .....	220
Table 93 – Fibre medium interface 5,0 Mbit/s, optical .....	220
Table 94 – Fibre signal specification 5 Mbit/s, optical medium, short range .....	221
Table 95 – Fibre signal specification 5 Mbit/s, optical medium, medium range .....	221
Table 96 – Fibre signal specification 5 Mbit/s, optical medium, long range .....	222
Table 97 – NAP requirements .....	224
Table 98 – Network powered device characteristics for the 31,25 kbit/s voltage-mode MAU .....	230
Table 99 – Network power supply requirements for the 31,25 kbit/s voltage-mode MAU.....	231
Table 100 – Cable specifications .....	238
Table 101 – Maximum cable length for the different transmission speeds .....	238
Table 102 – Characteristic Features .....	242
Table 103 – Characteristics of optical transmitters for multi-mode glass fibre.....	245
Table 104 – Characteristics of optical transmitters for single-mode glass fibre .....	246
Table 105 – Characteristics of optical transmitters for plastic fibre .....	246
Table 106 – Characteristics of optical transmitters for 200/230 glass fibre .....	246
Table 107 – Characteristics of optical receivers for multi-mode glass fibre.....	247
Table 108 – Characteristics of optical receivers for single-mode glass fibre .....	247
Table 109 – Characteristics of optical receivers for plastic fibre .....	247
Table 110 – Characteristics of optical receivers for 200/230 glass fibre .....	248
Table 111 – Permissible signal distortion at the electrical input of the optical transmitter ....	248
Table 112 – Permissible signal distortion due to the optical transmitter.....	249
Table 113 – Permissible signal distortion due to the optical receiver.....	250
Table 114 – Permissible signal influence due to internal electronic circuits of a coupling component .....	250
Table 115 – Maximum chaining of standard optical links without retiming .....	251
Table 116 – Services of the MDS-MAU interface, RS-485, Type 4 .....	252
Table 117 – Services of the MDS-MAU interface, RS-232, Type 4 .....	254
Table 118 – Minimum setting of the InterFrameGap parameter for RS-485 wire PhL .....	256
Table 119 – Maximum stub capacitance per Ph-segment versus bus data rate .....	258
Table 120 – Maximum cable length per Ph-segment versus bus data rate.....	259
Table 121 – Bit rate dependent quantities twisted pair wire medium MAU .....	261
Table 122 – Incoming interface signals .....	263
Table 123 – Outgoing interface signals .....	263
Table 124 – Remote bus cable characteristics .....	264

Table 125 – Bit rate dependent quantities optical MAU .....	266
Table 126 – Remote bus fibre optic cable length.....	267
Table 127 – Encoding rules .....	267
Table 128 – Transmit level and spectral specification summary for an optical MAU.....	268
Table 129 – Optical MAU receive circuit specification summary .....	269
Table 130 – Specification of the fibre optic waveguide .....	269
Table 131 – Specification of the single fibre.....	270
Table 132 – Specification of the cable sheath and mechanical properties of the cable .....	270
Table 133 – Recommended further material properties of the cable .....	270
Table 134 – Specification of the fibre optic waveguide .....	271
Table 135 – Specification of the single fibre.....	271
Table 136 – Specification of the cable sheath and mechanical properties of the cable .....	272
Table 137 – Specification of the standard test fibre for an optical MAU.....	272
Table A.1 – Internal connector dimensions.....	273
Table A.2 – Contact assignments for the external connector for harsh industrial environments .....	274
Table A.3 – Contact assignments for the external connector for typical industrial environments .....	278
Table A.4 – Fixed (device) side connector dimensions .....	278
Table A.5 – Free (cable) side connector dimensions.....	279
Table A.6 – Connector dimensions.....	280
Table B.1 – Typical cable specifications.....	281
Table B.2 – Recommended maximum spur lengths versus number of communication elements.....	282
Table C.1 – Optical passive star specification summary: example .....	283
Table D.1 – Passive star topology .....	285
Table D.2 – Active star topology .....	286
Table E.1 – Alternate fibres for dual-fibre mode .....	288
Table E.2 – Alternate fibres for single-fibre mode .....	288
Table F.1 – Connector requirements .....	289
Table F.2 – NAP connector pin definition .....	291
Table H.1 – 5 Mbit/s, voltage-mode, coaxial wire receiver output definitions .....	304
Table H.2 – Coaxial wire medium toroid specification.....	306
Table I.1 – Contact assignments for the external connector for harsh industrial environments .....	309
Table I.2 – Contact designations .....	310
Table K.1 – Example of a level budget calculation for multi-mode glass fibre 62,5/125 µm ..	320
Table K.2 – Example of a level budget calculation for single mode glass fibre 9/125 µm .....	320
Table K.3 – Example of a level budget calculation for multi-mode plastic fibre 980/1000 µm ..	321
Table K.4 – Example of a level budget calculation for multi-mode glass fibre 200/230 µm fibre .....	321
Table L.1 – Pin assignments for the 9-pin subminiature-D connector .....	322
Table M.1 – Pin assignment of the 9-position subminiature D connector .....	324
Table M.2 – Pin assignment of the terminal connector .....	325

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

# DIGITAL DATA COMMUNICATIONS FOR MEASUREMENT AND CONTROL – FIELDBUS FOR USE IN INDUSTRIAL CONTROL SYSTEMS –

## Part 2: Physical Layer specification and service definition

### FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
- 4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
- 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this International Standard may involve the use of patents as follows, where the [xx] notation indicates the holder of the patent right:

<https://stdb.iec.ch/standard/61158-2-2003>

5,396,197 [AB1] Network Node TAP

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

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

[AB]: Rockwell Technologies, LLC  
Allen-Bradley Co., LLC  
1201 So. Second Street  
Milwaukee, WI 53204  
USA  
Attention: Intellectual Property Dept.

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

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

The third edition cancels and replaces the second edition published in 2000 and its amendment. This third edition constitutes a technical revision.