



IEC 61784-5-2

Edition 4.0 2018-08

INTERNATIONAL STANDARD



**Industrial communication networks – Profiles –
Part 5-2: Installation of fieldbuses – Installation profiles for CPF 2**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 25.040.40; 35.100.40

ISBN 978-2-8322-5938-2

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	10
INTRODUCTION.....	12
1 Scope.....	13
2 Normative references	13
3 Terms, definitions and abbreviated terms	13
4 CPF 2: Overview of installation profiles	13
5 Installation profile conventions	14
6 Conformance to installation profiles.....	15
Annex A (normative) CP 2/1 (ControlNet™) specific installation profile	16
A.1 Installation profile scope.....	16
A.2 Normative references	16
A.3 Installation profile terms, definitions, and abbreviated terms.....	16
A.3.1 Terms and definitions.....	16
A.3.2 Abbreviated terms.....	16
A.3.3 Conventions for installation profiles	16
A.4 Installation planning	17
A.4.1 General.....	17
A.4.2 Planning requirements	18
A.4.3 Network capabilities.....	19
A.4.4 Selection and use of cabling components	25
A.4.5 Cabling planning documentation	43
A.4.6 Verification of cabling planning specification.....	43
A.5 Installation implementation	43
A.5.1 General requirements	43
A.5.2 Cable installation	43
A.5.3 Connector installation	45
A.5.4 Terminator installation	54
A.5.5 Device installation.....	54
A.5.6 Coding and labelling	56
A.5.7 Earthing and bonding of equipment and devices and shield cabling	57
A.5.8 As-implemented cabling documentation	58
A.6 Installation verification and installation acceptance test.....	58
A.6.1 General.....	58
A.6.2 Installation verification	58
A.6.3 Installation acceptance test.....	61
A.7 Installation administration.....	63
A.8 Installation maintenance and installation troubleshooting.....	63
A.8.1 General.....	63
A.8.2 Maintenance	63
A.8.3 Troubleshooting	63
A.8.4 Specific requirements for maintenance and troubleshooting.....	68
Annex B (normative) CP 2/2 (EtherNet/IP™) specific installation profile.....	69
B.1 Installation profile scope.....	69

B.2	Normative references	69
B.3	Installation profile terms, definitions, and abbreviated terms	69
B.3.1	Terms and definitions.....	69
B.3.2	Abbreviated terms.....	69
B.3.3	Conventions for installation profiles	70
B.4	Installation planning	70
B.4.1	General.....	70
B.4.2	Planning requirements	71
B.4.3	Network capabilities.....	71
B.4.4	Selection and use of cabling components	76
B.4.5	Cabling planning documentation	92
B.4.6	Verification of cabling planning specification	92
B.5	Installation implementation	92
B.5.1	General requirements	92
B.5.2	Cable installation	92
B.5.3	Connector installation	93
B.5.4	Terminator installation	94
B.5.5	Device installation.....	94
B.5.6	Coding and labelling	94
B.5.7	Earthing and bonding of equipment and devices and shield cabling	94
B.5.8	As-implemented cabling documentation	96
B.6	Installation verification and installation acceptance test.....	96
B.6.1	General.....	96
B.6.2	Installation verification	96
B.6.3	Installation acceptance test.....	98
B.7	Installation administration.....	99
B.8	Installation maintenance and installation troubleshooting.....	99
Annex C (normative)	CP 2/3 (DeviceNet™) specific installation profile.....	100
C.1	Installation profile scope.....	100
C.2	Normative references	100
C.3	Installation profile terms, definitions, and abbreviated terms	100
C.3.1	Terms and definitions.....	100
C.3.2	Abbreviated terms.....	100
C.3.3	Conventions for installation profiles	100
C.4	Installation planning	101
C.4.1	General.....	101
C.4.2	Planning requirements	102
C.4.3	Network capabilities.....	103
C.4.4	Selection and use of cabling components	119
C.4.5	Cabling planning documentation	129
C.4.6	Verification of cabling planning specification	129
C.5	Installation implementation	129
C.5.1	General requirements	129
C.5.2	Cable installation	129
C.5.3	Connector installation	131

C.5.4	Terminator installation	144
C.5.5	Device installation.....	146
C.5.6	Coding and labelling	150
C.5.7	Earthing and bonding of equipment and devices and shield cabling	150
C.5.8	As-implemented cabling documentation	151
C.6	Installation verification and installation acceptance test.....	151
C.6.1	General.....	151
C.6.2	Installation verification	151
C.6.3	Installation acceptance test.....	154
C.7	Installation administration.....	155
C.8	Installation maintenance and installation troubleshooting.....	155
C.8.1	General.....	155
C.8.2	Maintenance	155
C.8.3	Troubleshooting	155
C.8.4	Specific requirements for maintenance and troubleshooting.....	155
Annex D (informative)	Additional information	159
D.1	Network validation check sheet for CP 2/3 (DeviceNet)	159
	Bibliography.....	163
Figure 1	Standards relationships.....	12
Figure A.1	Interconnection of CPF 2 networks	17
Figure A.2	Overview of CPF 2/1 networks.....	18
Figure A.3	Drop cable requirements.....	20
Figure A.4	Placement of BNC/TNC plugs	20
Figure A.5	Placement of terminators	21
Figure A.6	Extending a network using repeaters	21
Figure A.7	Extending a network using active star topology.....	21
Figure A.8	Links.....	22
Figure A.9	Extending the network beyond 99 nodes.....	22
Figure A.10	Maximum allowable taps per segment.....	31
Figure A.11	Example of repeaters in star configuration	32
Figure A.12	Repeaters in parallel.....	33
Figure A.13	Repeaters in combination series and parallel.....	34
Figure A.14	Ring repeater.....	34
Figure A.15	Installing bulkheads	35
Figure A.16	Coaxial BNC and TNC terminators	36
Figure A.17	Terminator placement in a segment	36
Figure A.18	RC Shield Termination in Active Devices	38
Figure A.19	Redundant network icons.....	39
Figure A.20	Redundant coax media	39
Figure A.21	Redundant fibre media.....	39
Figure A.22	Repeaters in series versus length difference for coax media	40
Figure A.23	Repeaters in series versus length difference for fibre media	41
Figure A.24	Example of redundant coax network with repeaters.....	41
Figure A.25	Example of improper redundant node connection.....	42

Figure A.26 – Example tool kit for installing BNC connectors	46
Figure A.27 – Calibration of coaxial stripper.....	46
Figure A.28 – Coax PVC strip length detail (informative).....	47
Figure A.29 – Memory cartridge and blade.....	48
Figure A.30 – Cable position.....	48
Figure A.31 – Locking the cable.....	48
Figure A.32 – Stripping the cable	49
Figure A.33 – Install the crimp ferrule	49
Figure A.34 – Cable preparation for PVC type cables (informative).....	50
Figure A.35 – Cable preparation for FEP type cables (informative)	50
Figure A.36 – Strip guides	50
Figure A.37 – Using the flare tool.....	51
Figure A.38 – Expanding the shields.....	51
Figure A.39 – Install the centre pin	51
Figure A.40 – Crimping the centre pin.....	52
Figure A.41 – Installing the connector body	52
Figure A.42 – Installing the ferrule	52
Figure A.43 – Crimp tool	53
Figure A.44 – Sealed IP65/67 cable	54
Figure A.45 – Terminator placement	54
Figure A.46 – Mounting the taps	55
Figure A.47 – Mounting the tap assembly using the universal mounting bracket	56
Figure A.48 – Mounting the tap using tie wraps or screws.....	56
Figure A.49 – Redundant network icons.....	57
Figure A.50 – Network test tool.....	59
Figure A.51 – Shorting the cable to test for continuity	60
Figure A.52 – Testing fibre segments.....	62
Figure A.53 – Multi-fibre backbone cable housing	64
Figure A.54 – Repeater adapter module.....	64
Figure A.55 – Short and medium distance fibre module LEDs	66
Figure A.56 – Long and extra long repeater module LEDs	67
Figure B.1 – Interconnection of CPF 2 networks	70
Figure B.2 – Redundant linear bus.....	72
Figure B.3 – Peer-to-peer connections.....	72
Figure B.4 – Mated connections.....	75
Figure B.5 – The 8-way modular sealed jack & plug (plastic housing)	82
Figure B.6 – The 8-way modular sealed jack & plug (metal housing).....	82
Figure B.7 – M12-4 connectors	83
Figure B.8 – Example of a metallic shell M12-8 X-coding connectors	84
Figure B.9 – Simplex LC connector	85
Figure B.10 – Duplex LC connector	85
Figure B.11 – IP65/67 sealed duplex LC connector.....	85
Figure B.12 – IP65/67 sealed duplex SC-RJ connector	86

Figure B.13 – M12-4 to 8-way modular bulkhead	88
Figure B.14 – The 8-way modular sealed jack & plug (plastic housing)	93
Figure B.15 – The 8-way modular sealed jack & plug (metal housing)	93
Figure B.16 – M12-4 connectors	94
Figure B.17 – Earthing of cable shield	96
Figure C.1 – Interconnection of CPF 2 networks	101
Figure C.2 – Connection to generic cabling	102
Figure C.3 – DeviceNet cable system uses a trunk/drop line topology	104
Figure C.4 – Measuring the trunk length	106
Figure C.5 – Measuring the trunk and drop length	106
Figure C.6 – Measuring drop cable in a network with multiports	107
Figure C.7 – Removable device using open-style connectors	107
Figure C.8 – Fixed connection using open-style connector	108
Figure C.9 – Open-style connector pin out	108
Figure C.10 – Open-style connector pin out 10 position	108
Figure C.11 – Power Bus Current derate as a function of temperature differential	111
Figure C.12 – Power supply sizing example	112
Figure C.13 – Current limit for thick cable for one power supply	113
Figure C.14 – Example of a continuous power bus	114
Figure C.15 – Current limit for thick cable and two power supplies common V+	115
Figure C.16 – Worst-case scenario	116
Figure C.17 – Example using the lookup method	116
Figure C.18 – One power supply end connected	118
Figure C.19 – Segmenting power in the power bus	119
Figure C.20 – Segmenting the power bus using power taps	119
Figure C.21 – Thick cable construction	130
Figure C.22 – Cable Type I construction	130
Figure C.23 – Thin cable construction	131
Figure C.24 – Flat cable construction	131
Figure C.25 – Cable preparation	132
Figure C.26 – Connector assembly	132
Figure C.28 – M12 connector pin assignment	133
Figure C.29 – Mini connector pin assignment	133
Figure C.30 – Preparation of cable end	134
Figure C.31 – Shrink wrap installation	134
Figure C.32 – Wire preparation	134
Figure C.33 – Open-style connector (female)	135
Figure C.34 – Open-style (male plug)	135
Figure C.35 – Flat cable	136
Figure C.36 – Aligning the cable	136
Figure C.37 – Closing the assembly	137
Figure C.38 – Proper orientation of cable	137
Figure C.39 – Locking the assembly	137

Figure C.40 – Driving the IDC contacts in to the cable	138
Figure C.41 – End cap placement	138
Figure C.42 – End cap seated.....	139
Figure C.43 – End cap installation on alternate side of cable	139
Figure C.44 – Flat cable IDC connectors.....	140
Figure C.45 – Installing the connectors	140
Figure C.46 – Cable wiring to open-style terminals	141
Figure C.47 – Auxiliary power cable profile	141
Figure C.48 – Pin out auxiliary power connectors.....	142
Figure C.49 – Power supply cable length versus wire size	143
Figure C.50 – Sealed terminator	145
Figure C.51 – Open-style terminator	145
Figure C.52 – Open-style IDC terminator	145
Figure C.53 – Sealed terminator IDC cable	146
Figure C.54 – Direct connection to the trunk	147
Figure C.55 – Wiring of open-style connector.....	147
Figure C.56 – Wiring of open-style 10-position connector	147
Figure C.57 – Diagnostic temporary connections	148
Figure C.58 – Thick cable preterminated cables (cord sets).....	149
Figure C.59 – Thin cable preterminated cables (cord sets).....	149
Table A.1 – Basic network characteristics for balanced cabling not based on Ethernet	23
Table A.2 – Network characteristics for optical fibre cabling.....	24
Table A.3 – RG6 coaxial electrical properties.....	26
Table A.4 – RG6 coaxial physical parameters	26
Table A.5 – Cable type selection.....	27
Table A.6 – Information relevant to optical fibre cables	28
Table A.7 – Copper connectors for ControlNet.....	29
Table A.8 – Optical fibre connecting hardware	29
Table A.9 – Relationship between FOC and fibre types (CP 2/1).....	30
Table A.10 – Parameters for coaxial RG6 cables	44
Table A.11 – Bend radius for coaxial cables outside conduit.....	44
Table A.12 – Parameters for silica optical fibre cables	44
Table A.13 – Parameters for hard clad silica optical fibre.....	45
Table A.14 – Test matrix for BNC/TNC connectors.....	60
Table A.15 – Wavelength and fibre types.....	63
Table A.16 – LED status table.....	65
Table A.17 – Repeater adapter and module diagnostic	65
Table A.18 – Repeater adapter indicator diagnostic	65
Table A.19 – Repeater module indicator	66
Table A.20 – Short and medium distance troubleshooting chart	67
Table A.21 – Long and extra long troubleshooting chart.....	68
Table B.1 – Network characteristics for balanced cabling based on Ethernet	73

Table B.2 – Network characteristics for optical fibre cabling.....	74
Table B.3 – Fibre lengths for 1 mm POF A4a.2 POF 0.5 NA	74
Table B.4 – Fibre lengths for 1 mm POF A4d POF 0.3 NA	75
Table B.5 – Recognized fibre types.....	76
Table B.6 – Recognized fibre PMDs.....	76
Table B.7 – Information relevant to copper cable: fixed cables 10/100 MHz	77
Table B.8 – Information relevant to copper cable: fixed cables 1 000 MHz	77
Table B.9 – Information relevant to copper cable: cords 10/100 MHz	78
Table B.10 – TCL limits for unshielded twisted-pair cabling serving 10/100 Mb/s	79
Table B.11 – TCL limits for unshielded twisted-pair cabling serving 1 000 Mb/s	79
Table B.12 – ELTCTL limits for unshielded twisted-pair cabling serving 10/100 Mb/s	79
Table B.13 – ELTCTL limits for unshielded twisted-pair cabling serving 1 000 Mb/s	79
Table B.14 – Coupling attenuation limits for screened twisted-pair cabling.....	80
Table B.15 – Information relevant to optical fibre cables	80
Table B.16 – Connectors for balanced cabling CPs based on Ethernet	81
Table B.17 – TCL limits for connectors based on Ethernet serving 1 000 Mb/s.....	81
Table B.18 – Industrial EtherNet/IP 8-way modular connector parameters	82
Table B.19 – Industrial EtherNet/IP M12-4 D-coding connector parameters	82
Table B.20 – Industrial EtherNet/IP M12-8 X-coding connector parameters.....	83
Table B.21 – Optical fibre connecting hardware	84
Table B.22 – Relationship between FOC and fibre types (CP2/2).....	86
Table B.23 – Connector insertion loss.....	86
Table B.24 – Parameters for balanced cables	92
Table B.25 – Parameters for silica optical fibre cables	92
Table B.26 – Parameters for POF optical fibre cables	93
Table C.1 – Basic network characteristics for copper cabling not based on Ethernet.....	104
Table C.2 – Cable trunk and drop lengths for CP 2/3	105
Table C.3 – Summary of available current for trunk cables (CP 2/3).....	109
Table C.4 – Permissible current for thin cable drop lines of various lengths	110
Table C.5 – Power supply specification for DeviceNet.....	110
Table C.6 – Power supply tolerance stack up for DeviceNet.....	111
Table C.7 – Current versus cable length for one power supply thick cable	114
Table C.8 – Current versus length for two power supplies.....	115
Table C.9 – Definition of equation variables	117
Table C.10 – Information relevant to copper cable: fixed cables.....	120
Table C.11 – Information relevant to copper cable: cords.....	120
Table C.12 – DeviceNet cables and connector support cross reference	121
Table C.13 – DeviceNet cable profiles	122
Table C.14 – Copper connectors for non-Ethernet based fieldbus	124
Table C.15 – Additional connectors for CP 2/3 (DeviceNet)	124
Table C.16 – Parameters for balanced cables.....	129
Table C.17 – Wire colour code and function.....	135
Table C.18 – Auxiliary power cable colour code.....	141

Table C.19 – Auxiliary power supply requirements 142

Table C.20 – Signal wire verification 152

Table C.21 – Shield to earth 152

Table C.22 – Connector pin out 154

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL COMMUNICATION NETWORKS – PROFILES –

Part 5-2: Installation of fieldbuses – Installation profiles for CPF 2

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61784-5-2 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 2013. This edition constitutes a technical revision.

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

- a) references to ISO/IEC 24702 have been replaced with references to ISO/IEC 11801-3 in Table B.1;
- b) errors have been corrected;
- c) Tables B11 and B13 have been added in support of 1,000 Mb/s 4 Pair Ethernet;

d) Clarification of dual power supplies for Annex C.

This standard is to be used in conjunction with IEC 61918:2018.

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

FDIS	Report on voting
65C/924/FDIS	65C/925/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 document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 61784-5 series, under the general title *Industrial communication networks – Profiles – Installation of fieldbuses*, can be found on the IEC website.

The committee has decided that the contents of this document 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 document. At this date, the document 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 International Standard is one of a series produced to facilitate the use of communication networks in industrial control systems.

IEC 61918:2018 provides the common requirements for the installation of communication networks in industrial control systems. This installation profile standard provides the installation profiles of the communication profiles (CP) of a specific communication profile family (CPF) by stating which requirements of IEC 61918 fully apply and, where necessary, by supplementing, modifying, or replacing the other requirements (see Figure 1).

For general background on fieldbuses, their profiles, and relationship between the installation profiles specified in this document, see IEC 61158-1.

Each CP installation profile is specified in a separate annex of this document. Each annex is structured exactly as the reference standard IEC 61918 for the benefit of the persons representing the roles in the fieldbus installation process as defined in IEC 61918 (planner, installer, verification personnel, validation personnel, maintenance personnel, administration personnel). By reading the installation profile in conjunction with IEC 61918, these persons immediately know which requirements are common for the installation of all CPs and which are modified or replaced. The conventions used to draft this document are defined in Clause 5.

The provision of the installation profiles in one standard for each CPF (for example IEC 61784-5-2 for CPF 2) allows readers to work with standards of a convenient size.

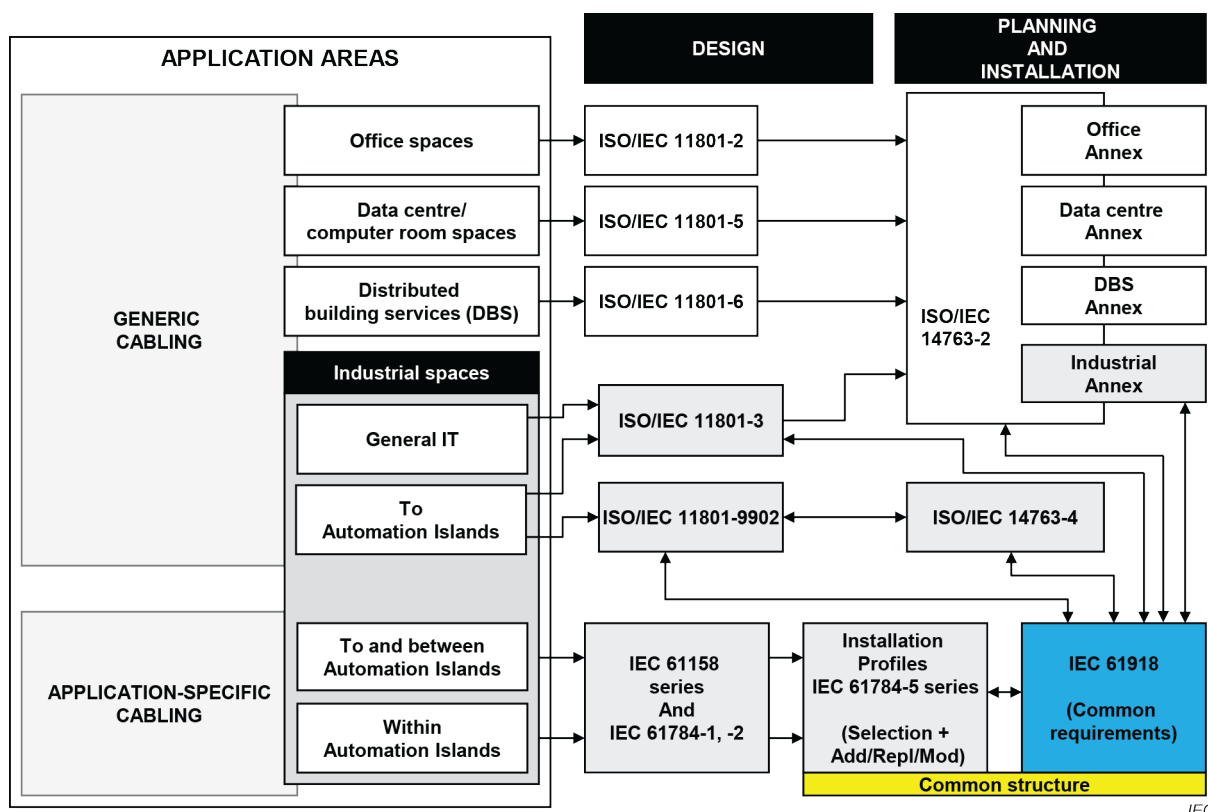


Figure 1 – Standards relationships

INDUSTRIAL COMMUNICATION NETWORKS – PROFILES –

Part 5-2: Installation of fieldbuses – Installation profiles for CPF 2

1 Scope

This part of IEC 61784-5 specifies the installation profiles for CPF 2 (CIP™¹).

The installation profiles are specified in the annexes. These annexes are read in conjunction with IEC 61918:2018.

2 Normative references

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

IEC 61918:2018, *Industrial communication networks – Installation of communication networks in industrial premises*

The normative references of IEC 61918:2018, Clause 2, apply.

NOTE For profile specific normative references, see Clauses A.2, B.2, and C.2.

¹ CIP™ (Common Industrial Protocol) is a trade name of ODVA, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this document does not require use of the trade name CIP™. Use of the trade name CIP™ requires permission of ODVA, Inc.