

**Industrial communication networks - Installation of  
communication networks in industrial premises**

This document is a preview generated by EVS

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

See Eesti standard EVS-EN 61918:2013 sisaldab Euroopa standardi EN 61918:2013 inglisekeelset teksti.	This Estonian standard EVS-EN 61918:2013 consists of the English text of the European standard EN 61918:2013.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 13.12.2013.	Date of Availability of the European standard is 13.12.2013.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile [standardiosakond@evs.ee](mailto:standardiosakond@evs.ee).

ICS 25.040.40, 33.020, 35.240.50

### Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:  
Aru 10, 10317 Tallinn, Eesti; [www.evs.ee](http://www.evs.ee); telefon 605 5050; e-post [info@evs.ee](mailto:info@evs.ee)

### The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:  
Aru 10, 10317 Tallinn, Estonia; [www.evs.ee](http://www.evs.ee); phone 605 5050; e-mail [info@evs.ee](mailto:info@evs.ee)

English version

**Industrial communication networks -  
Installation of communication networks in industrial premises  
(IEC 61918:2013, modified)**

Réseaux de communication industriels -  
Installation de réseaux de communication  
dans des locaux industriels  
(CEI 61918:2013, modifiée)

Industrielle Kommunikationsnetze –  
Installation von Kommunikationsnetzen in  
Industrieanlagen  
(IEC 61918:2013, modifiziert)

This European Standard was approved by CENELEC on 2013-10-02. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

**CENELEC**

European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

**CEN-CENELEC Management Centre: Avenue Marnix 17, B - 1000 Brussels**

## Foreword

The text of document 65C/737/FDIS, future edition 3 of IEC 61918, prepared by SC 65C, "Industrial networks", of IEC/TC 65, "Industrial-process measurement, control and automation" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61918:2013.

A draft amendment, which covers common modifications to IEC 61918:2013, was prepared by CLC/TC 65X, "Industrial-process measurement, control and automation" and approved by CENELEC.

The following dates are fixed:

- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2014-10-02
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) 2016-10-02

This document supersedes EN 61918:2008.

EN 61918:2013 includes the following significant technical changes with respect to EN 61918:2008:

- some terms and abbreviated terms have been added to Clause 3;
- Subclauses 4.4.3.4.1, 4.4.7.2.1, and 4.4.7.3 have been updated;
- Subclause 5.7.4.3 has been updated as result of the revision of the installation profiles;
- Subclause 6.2.3.1 has been updated;
- Subclause 8.1 has been updated;
- Figure 2, Figure 13, Figure 15, Figure 29, Figure H.1, Table 3, Table 6, Table 7, Table 14, Table B.3 and Table B.5 have been updated;
- a new Figure 35 has been added;
- a new Table 10 has been added;
- Annex D and Annex M have been extended to cover additional communication profile families;
- Annex F has been extended to cover conductor sizes in electrical cables;
- Annex H has been made normative; some common requirements are extended as result of the revision of the installation profiles;
- a new informative Annex O has been added.

This standard is to be used in conjunction with the EN 61784-5 series with regard to the installation of communication profiles (CPs). This standard is to be used in conjunction with ISO/IEC 14763-2 with regard to the installation of generic cabling in accordance with EN 50173-3.

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

## Endorsement notice

The text of the International Standard IEC 61918:2013 was approved by CENELEC as a European Standard with agreed common modifications.

## COMMON MODIFICATIONS

### • Introduction

**Replace** the last paragraph before Figure 2 by:

For the installation of generic cabling this standard is to be used in conjunction with EN 50174 (see Figure 2).

### • Figure 2 – Standards relationships

**Replace** the original figure by the following one, which shows the standards relationships at European level:

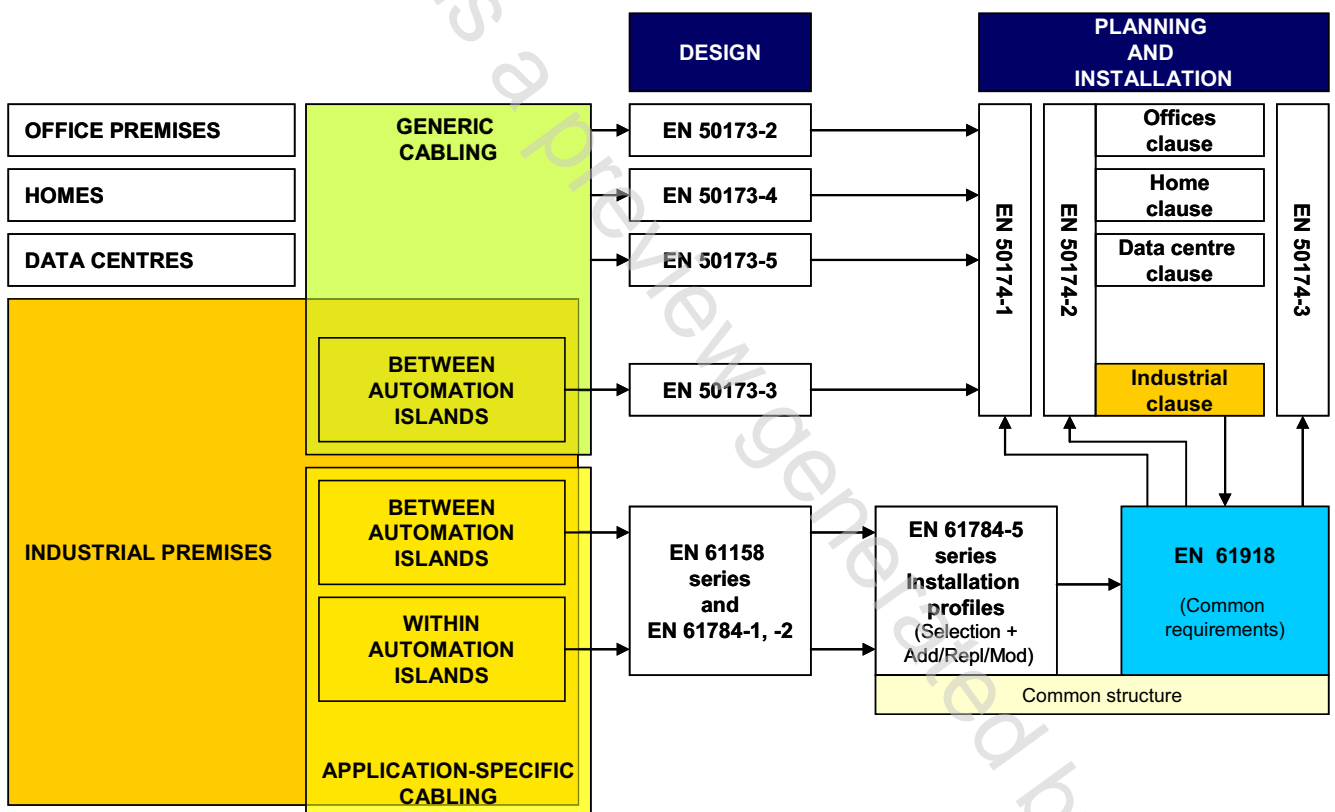


Figure 2 - Network installation: Standards relationships at European level

### • 2 Normative references

In EN 61918 the normative references shall be modified as follows: EN 50288 replaces IEC 61156 and HD 60364 replaces IEC 60364.

- In IEC 61918 the generic cabling is intended as 'in accordance with ISO/IEC 24702'.

In EN 61918 the generic cabling shall be intended as 'in accordance with EN 50173-3'.

- In the Bibliography, **add** the following notes for the standards indicated:

IEC 60060-1	NOTE Harmonized as EN 60060-1.
IEC 60079-11:2011	NOTE Harmonized as EN 60079-11:2012 (not modified).
IEC 60079-14	NOTE Harmonized as EN 60079-14.
IEC 60228	NOTE Harmonized as EN 60228.
IEC 60332-1 series	NOTE Harmonized in EN 60332-1 series.
IEC 60364 series	NOTE Harmonized in EN/HD 60364 series.
IEC 60512-4 series	NOTE Harmonized in EN 60512-4 series.
IEC 60664-1	NOTE Harmonized as EN 60664-1.
IEC 60670-1:2002	NOTE Harmonized as EN 60670-1:2005 (modified).
IEC 60950-21	NOTE Harmonized as EN 60950-21.
IEC 61000-4-4	NOTE Harmonized as EN 61000-4-4.
IEC 61000-6-2	NOTE Harmonized as EN 61000-6-2.
IEC 61000-6-4	NOTE Harmonized as EN 61000-6-4.
IEC 61010-1	NOTE Harmonized as EN 61010-1.
IEC 61131-2:2007	NOTE Harmonized as EN 61131-2:2007 (not modified).
IEC 61508-4	NOTE Harmonized as EN 61508-4.
IEC 61984:2008	NOTE Harmonized as EN 61984:2009 (not modified).

## Annex ZA (normative)

### Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
-	-	Multi-element metallic cables used in analogue and digital communication and control	EN 50288	Series
-	-	Application of equipotential bonding and earthing in buildings with information technology equipment	EN 50310	-
IEC 60364-1 (mod) + corr. August	2005 2009	Low-voltage electrical installations - Part 1: Fundamental principles, assessment of general characteristics, definitions	HD 60364-1	2008
IEC 60364-4-41	-	Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock	HD 60364-4-41	-
IEC 60364-4-44	-	Low-voltage electrical installations - Part 4-44: Protection for safety - Protection against voltage disturbances and electromagnetic disturbances	HD 60364-4-442	-
IEC 60364-5-54	-	Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements and protective conductors	HD 60364-5-54	-
IEC 60529	-	Degrees of protection provided by enclosures (IP Code)	EN 60529	-
IEC 60603	Series	Connectors for frequencies below 3 MHz for use with printed boards	EN 60603	Series
IEC 60603-7	Series	Connectors for electronic equipment - Part 7: Detail specification for 8-way, shielded, free and fixed connectors	EN 60603-7	Series
IEC 60757	-	Code for designation of colours	HD 457 S1	-
IEC 60793	Series	Optical fibres	EN 60793	Series
IEC 60793-2-10	-	Optical fibres - Part 2-10: Product specifications - Sectional specification for category A1 multimode fibres	EN 60793-2-10	-
IEC 60794	Series	Optical fibre cables	EN 60794	Series
IEC 60807-2	-	Rectangular connectors for frequencies below 3-MHz - Part 2: Detail specification for a range of connectors, with assessed quality, with trapezoidal shaped metal shells and round contacts - Fixed solder contact types	-	-

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
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 types with closed crimp barrels, rear insertion/rear extraction		-
IEC 60825-2	-	Safety of laser products - Part 2: Safety of optical fibre communication systems (OFCS)	EN 60825-2	-
IEC 60950-1	-	Information technology equipment - Safety - Part 1: General requirements	EN 60950-1	-
IEC 61076-2-101	-	Connectors for electronic equipment - Product requirements - Part 2-101: Circular connectors - Detail specification for M12 connectors with screw-locking	EN 61076-2-101	-
IEC/PAS 61076-2-109	-	Connectors for electronic equipment - Product requirements - Part 2-109: Circular connectors - Detail specification for connectors M12 x 1 with screw-locking, for data transmissions with frequencies up to 500 MHz	-	-
IEC 61076-3-106	-	Connectors for electronic equipment - Product requirements - Part 3-106: Rectangular connectors - Detail specification for protective housings for use with 8-way shielded and unshielded connectors for industrial environments incorporating the IEC 60603-7 series interface	EN 61076-3-106	-
IEC 61076-3-117	-	Connectors for electronic equipment - Product requirements - Part 3-117: Rectangular connectors - Detail specification for protective housings for use with 8-way shielded and unshielded connectors for industrial environments incorporating the IEC 60603-7 series interface - Variant 14 related to IEC 61076-3-106 - Push pull coupling	EN 61076-3-117	-
IEC 61158	Series	Industrial communication networks - Fieldbus specifications	EN 61158	Series
IEC 61158-2	201X <sup>1)</sup>	Industrial communication networks - Fieldbus specifications - Part 2: Physical layer specification and service definition	EN 61158-2	201X <sup>1)</sup>
IEC 61169-8	-	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 - Characteristics impedance 50 ohms (type BNC)	EN 61169-8	-
IEC 61753	Series	Fibre optic interconnecting devices and passive components performance standard	EN 61753	Series

<sup>1)</sup> To be published.



<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61754-2	-	Fibre optic connector interfaces - Part 2: Type BFOC/2,5 connector family	EN 61754-2	-
IEC 61754-4	-	Fibre optic interconnecting devices and passive components - Fibre optic connector interfaces - Part 4: Type SC connector family	EN 61754-4	-
IEC 61754-20	-	Fibre optic interconnecting devices and passive components - Fibre optic connector interfaces - Part 20: Type LC connector family	EN 61754-20	-
IEC 61754-22	-	Fibre optic connector interfaces - Part 22: Type F-SMA connector family	EN 61754-22	-
IEC 61754-24	-	Fibre optic interconnecting devices and passive components - Fibre optic connector interfaces - Part 24: Type SC-RJ connector family	EN 61754-24	-
IEC 61784	Series	Industrial communication networks - Profiles	EN 61784	Series
IEC 61784-1	-	Industrial communication networks - Profiles - Part 1: Fieldbus profiles	EN 61784-1	-
IEC 61784-2	201X <sup>1)</sup>	Industrial communication networks - Profiles - Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC 8802-3	EN 61784-2	201X <sup>1)</sup>
IEC 61784-3	-	Industrial communication networks - Profiles - Part 3: Functional safety fieldbuses - General rules and profile definitions	EN 61784-3	-
IEC 61784-5	Series	Industrial communication networks - Profiles - Part 5-2: Installation of fieldbuses - Installation profiles for CPF 2	EN 61784-5	Series
IEC 61935-1 (mod) + corr. October	2009 2010	Specification for the testing of balanced and coaxial information technology cabling - Part 1: Installed balanced cabling as specified in ISO/IEC 11801 and related standards	EN 61935-1	2009
IEC 61935-2	-	Specification for the testing of balanced and coaxial information technology cabling - Part 2: Cords as specified in ISO/IEC 11801 and related standards	EN 61935-2	-
IEC 62026-3	-	Low-voltage switchgear and controlgear - Controller-device interfaces (CDIs) - Part 3: DeviceNet	EN 62026-3	-
IEC 62439	Series	Industrial communication networks - High availability automation networks	EN 62439	Series
IEC 62443	Series	Industrial communication networks - Network and system security	-	-
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 11801 + corr. October + corr. December + A1 + A2	2002 2002 2002 2008 2010	Information technology - Generic cabling for customer premises	-	-

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
ISO/IEC 14763-2	2012	Information technology - Implementation and operation of customer premises cabling - Part 2: Planning and installation	-	-
ISO/IEC 14763-3	-	Information technology - Implementation and operation of customer premises cabling - Part 3: Testing of optical fibre cabling	-	-
ISO/IEC 24702 +A1	2006 2009	Information technology - Generic cabling - Industrial premises	-	-
IEEE 802.3	-	Standard for Information Technology – Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications	-	-
IEEE 802.3at	-	Standard for Information Technology – Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications - Amendment 3: Data Terminal Equipment (DTE) Power Via the Media Dependent Interface (MDI) Enhancements	-	-
ANSI/NFPA T3.5.29 R1	2007	Fluid power systems and components - Electrically-controlled industrial valves - Interface dimensions for electrical connectors	-	-

## CONTENTS

FOREWORD.....	10
INTRODUCTION.....	12
1 Scope.....	15
2 Normative references .....	15
3 Terms, definitions, and abbreviated terms .....	18
3.1 Terms and definitions .....	18
3.2 Abbreviated terms .....	28
3.3 Conventions for installation profiles .....	30
4 Installation planning .....	30
4.1 General.....	30
4.1.1 Objective .....	30
4.1.2 Cabling in industrial premises .....	30
4.1.3 The planning process .....	33
4.1.4 Specific requirements for CPs .....	34
4.1.5 Specific requirements for generic cabling in accordance with ISO/IEC 24702 .....	34
4.2 Planning requirements.....	34
4.2.1 Safety.....	34
4.2.2 Security .....	34
4.2.3 Environmental considerations and EMC.....	35
4.2.4 Specific requirements for generic cabling in accordance with ISO/IEC 24702 .....	36
4.3 Network capabilities .....	36
4.3.1 Network topology.....	36
4.3.2 Network characteristics .....	38
4.4 Selection and use of cabling components .....	42
4.4.1 Cable selection.....	42
4.4.2 Connecting hardware selection .....	46
4.4.3 Connections within a channel/permanent link .....	48
4.4.4 Terminators .....	54
4.4.5 Device location and connection .....	55
4.4.6 Coding and labelling .....	55
4.4.7 Earthing and bonding of equipment and devices and shielded cabling .....	55
4.4.8 Storage and transportation of cables .....	65
4.4.9 Routing of cables.....	65
4.4.10 Separation of circuits.....	67
4.4.11 Mechanical protection of cabling components.....	68
4.4.12 Installation in special areas .....	69
4.5 Cabling planning documentation.....	69
4.5.1 Common description .....	69
4.5.2 Cabling planning documentation for CPs .....	69
4.5.3 Network certification documentation .....	70
4.5.4 Cabling planning documentation for generic cabling in accordance with ISO/IEC 24702 .....	70
4.6 Verification of cabling planning specification .....	70
5 Installation implementation .....	70
5.1 General requirements.....	70

5.1.1	Common description .....	70
5.1.2	Installation of CPs .....	70
5.1.3	Installation of generic cabling in industrial premises .....	70
5.2	Cable installation.....	70
5.2.1	General requirements for all cabling types .....	70
5.2.2	Installation and routing .....	77
5.2.3	Specific requirements for CPs .....	78
5.2.4	Specific requirements for wireless installation.....	78
5.2.5	Specific requirements for generic cabling in accordance with ISO/IEC 24702 .....	78
5.3	Connector installation.....	78
5.3.1	Common description .....	78
5.3.2	Shielded connectors .....	79
5.3.3	Unshielded connectors .....	79
5.3.4	Specific requirements for CPs .....	79
5.3.5	Specific requirements for wireless installation.....	79
5.3.6	Specific requirements for generic cabling in accordance with ISO/IEC 24702 .....	79
5.4	Terminator installation.....	79
5.4.1	Common description .....	79
5.4.2	Specific requirements for CPs .....	80
5.5	Device installation .....	80
5.5.1	Common description .....	80
5.5.2	Specific requirements for CPs .....	80
5.6	Coding and labelling.....	80
5.6.1	Common description .....	80
5.6.2	Specific requirements for CPs .....	80
5.7	Earthing and bonding of equipment and devices and shield cabling.....	80
5.7.1	Common description .....	80
5.7.2	Bonding and earthing of enclosures and pathways .....	81
5.7.3	Earthing methods .....	82
5.7.4	Shield earthing methods .....	84
5.7.5	Specific requirements for CPs .....	86
5.7.6	Specific requirements for generic cabling in accordance with ISO/IEC 24702 .....	86
5.8	As-implemented cabling documentation.....	86
6	Installation verification and installation acceptance test.....	87
6.1	General .....	87
6.2	Installation verification.....	87
6.2.1	General .....	87
6.2.2	Verification according to cabling planning documentation .....	88
6.2.3	Verification of earthing and bonding .....	89
6.2.4	Verification of shield earthing .....	90
6.2.5	Verification of cabling system .....	90
6.2.6	Cable selection verification .....	90
6.2.7	Connector verification .....	91
6.2.8	Connection verification .....	91
6.2.9	Terminators verification .....	92
6.2.10	Coding and labelling verification .....	93

6.2.11	Verification report .....	93
6.3	Installation acceptance test .....	93
6.3.1	General .....	93
6.3.2	Acceptance test of Ethernet-based cabling .....	95
6.3.3	Acceptance test of non-Ethernet-based cabling .....	97
6.3.4	Specific requirements for wireless installation .....	98
6.3.5	Acceptance test report .....	98
7	Installation administration .....	98
7.1	General .....	98
7.2	Fields covered by the administration .....	99
7.3	Basic principles for the administration system .....	99
7.4	Working procedures .....	99
7.5	Device location labelling .....	100
7.6	Component cabling labelling .....	100
7.7	Documentation .....	101
7.8	Specific requirements for administration .....	101
8	Installation maintenance and installation troubleshooting .....	101
8.1	General .....	101
8.2	Maintenance .....	102
8.2.1	Scheduled maintenance .....	102
8.2.2	Condition-based maintenance .....	104
8.2.3	Corrective maintenance .....	104
8.3	Troubleshooting .....	104
8.3.1	General description .....	104
8.3.2	Evaluation of the problem .....	105
8.3.3	Typical problems .....	105
8.3.4	Troubleshooting procedure .....	108
8.3.5	Simplified troubleshooting procedure .....	109
8.4	Specific requirements for maintenance and troubleshooting .....	110
Annex A (informative)	Overview of generic cabling for industrial premises .....	111
Annex B (informative)	MICE description methodology .....	112
B.1	General .....	112
B.2	Overview of MICE .....	112
B.3	Examples of use of the MICE concept .....	113
B.3.1	Common description .....	113
B.3.2	Examples of mitigation .....	114
B.4	Determining E classification .....	115
B.5	The MICE table .....	118
Annex C (informative)	Network topologies .....	120
C.1	Common description .....	120
C.2	Total cable demand .....	120
C.3	Maximum cable segment length .....	120
C.4	Maximum network length .....	120
C.5	Fault tolerance .....	120
C.5.1	General .....	120
C.5.2	Use of redundancy .....	120
C.5.3	Failure analysis for networks with redundancy .....	121

C.6 Network access for diagnosis convenience.....	121
C.7 Maintainability and on-line additions .....	121
Annex D (informative) Connector tables .....	122
Annex E (informative) Power networks with respect to electromagnetic interference – TN-C and TN-S approaches .....	135
Annex F (informative) Conductor sizes in electrical cables .....	137
Annex G (informative) Installed cabling verification checklists.....	139
G.1 General .....	139
G.2 Copper cabling verification checklist.....	139
G.3 Optical fibre cabling verification checklist .....	143
Annex H (normative) Cord sets .....	144
H.1 General .....	144
H.2 Constructing cord sets .....	144
H.2.1 Straight through cord sets with M12-4 D-coding connectors .....	144
H.2.2 Crossover cord sets with M12-4 D-coding connectors.....	145
H.2.3 Straight through cord sets with 8-way modular connectors .....	145
H.2.4 Crossover cord sets with 8-way modular connectors .....	146
H.2.5 Straight conversion from one connector family to another.....	147
H.2.6 Crossover conversion from one connector family to another .....	147
Annex I (informative) Guidance for terminating cable ends .....	149
I.1 General .....	149
I.2 Guidance for terminating shielded twisted pair cable ends for 8-way modular plugs.....	149
I.3 Guidance for terminating unshielded twisted pair cable ends for 8-way modular plugs .....	152
I.4 Guidance for M12-4 D-coding connector installation .....	153
I.5 Guidance for terminating optical fibre cable ends .....	155
Annex J (informative) Recommendations for bulkhead connection performance and channel performance with more than 4 connections in the channel .....	156
J.1 General .....	156
J.2 Recommendations .....	156
Annex K (informative) Fieldbus data transfer testing .....	157
K.1 Background .....	157
K.2 Allowable error rates for control systems .....	157
K.2.1 Bit errors .....	157
K.2.2 Burst errors .....	157
K.3 Testing channel performance .....	158
K.4 Testing cable parameters .....	158
K.4.1 General .....	158
K.4.2 Generic cable testing.....	158
K.4.3 Fieldbus cable testing.....	159
K.5 Testing fieldbus data rate performance.....	159
K.5.1 General .....	159
K.5.2 Fieldbus test .....	159
K.5.3 Planning for fieldbus data rate testing .....	159
K.5.4 Fieldbus data rate test reporting template .....	160
K.5.5 Values for acceptable fieldbus performance .....	160

Annex L (informative) Communication network installation work responsibility .....	161
L.1 General .....	161
L.2 Installation work responsibility .....	161
L.3 Installation work responsibility table .....	161
Annex M (informative) Trade names of communication profiles .....	162
Annex N (informative) Validation measurements .....	165
N.1 General .....	165
N.2 DCR measurements .....	165
N.2.1 Purpose of test .....	165
N.2.2 Assumptions .....	165
N.2.3 Measurements .....	165
N.2.4 Calculations .....	167
N.2.5 Measurement results .....	167
Annex O (informative) End-to-end link .....	171
O.1 General .....	171
O.2 End-to-end link .....	171
O.3 Deliverables .....	172
O.4 End-to-end link test schedules and methods .....	172
O.4.1 End-to-end link test method 1 .....	172
O.4.2 End-to-end link test method 2 .....	173
Bibliography .....	174
Figure 1 – Industrial network installation life cycle .....	13
Figure 2 – Standards relationships .....	14
Figure 3 – Structure of generic cabling connected to an automation island .....	31
Figure 4 – Automation island cabling attached to elements of generic cabling .....	31
Figure 5 – Automation islands .....	32
Figure 6 – Automation island network external connections .....	32
Figure 7 – How to meet environmental conditions .....	36
Figure 8 – How enhancement, isolation and separation work together .....	36
Figure 9 – Basic physical topologies for passive networks .....	37
Figure 10 – Basic physical topologies for active networks .....	37
Figure 11 – Example of combination of basic topologies .....	38
Figure 12 – Basic reference implementation model .....	49
Figure 13 – Enhanced reference implementation model .....	51
Figure 14 – Selection of the earthing and bonding systems .....	58
Figure 15 – Wiring for bonding and earthing in an equipotential configuration .....	60
Figure 16 – Wiring of the earths in a star earthing configuration .....	61
Figure 17 – Schematic diagram of a field device with direct earthing .....	62
Figure 18 – Schematic diagram of a field device with parallel RC circuit earthing .....	63
Figure 19 – Insert edge protector .....	72
Figure 20 – Use an uncoiling device and avoid forming loop .....	73
Figure 21 – Avoid torsion .....	73
Figure 22 – Maintain minimum bending radius .....	74

Figure 23 – Do not pull by the individual wires .....	74
Figure 24 – Use cable clamps with a large (wide) surface .....	74
Figure 25 – Cable gland with bending protection .....	75
Figure 26 – Spiral tube .....	75
Figure 27 – Separate cable pathways .....	78
Figure 28 – Use of flexible bonding straps at movable metallic pathways .....	81
Figure 29 – Surface preparation for earthing and bonding electromechanical connections .....	82
Figure 30 – Example of isolated bus bar .....	83
Figure 31 – Example of isolator for mounting DIN rails .....	84
Figure 32 – Parallel RC shield earthing .....	84
Figure 33 – Direct shield earthing .....	85
Figure 34 – Examples for shielding application .....	85
Figure 35 – Voltage offset mitigation .....	86
Figure 36 – First example of derivatives of shield earthing .....	86
Figure 37 – Second example of derivatives of shield earthing .....	86
Figure 38 – Installation verification process .....	88
Figure 39 – Test of earthing connections .....	89
Figure 40 – Pin and pair grouping assignments for two eight position IEC 60603-7 subparts and four position IEC 60603 series to IEC 61076-2-101 connectors .....	92
Figure 41 – Two pair 8-way modular connector .....	92
Figure 42 – Transposed pairs, split pairs and reversed pair .....	92
Figure 43 – Validation process .....	94
Figure 44 – Schematic representation of the channel .....	95
Figure 45 – Schematic representation of the permanent link .....	95
Figure 46 – Communication network maintenance .....	103
Figure 47 – Troubleshooting procedure .....	108
Figure 48 – Fault detection without special tools .....	109
Figure B.1 – MICE classifications .....	112
Figure B.2 – Example MICE classifications within a facility .....	113
Figure B.3 – Enhancement, isolation and separation .....	113
Figure B.4 – Example 1 of mitigation .....	114
Figure B.5 – Example 2 of mitigation .....	115
Figure B.6 – Frequency range of electromagnetic disturbance from common industrial devices .....	115
Figure B.7 – Example of a general guidance for separation versus EFT value .....	117
Figure E.1 – Four-wire power network (TN-C) .....	135
Figure E.2 – Five wire power network (TN-S) .....	136
Figure H.1 – Straight through cord sets with M12-4 D-coding connectors .....	144
Figure H.2 – Straight through cord sets with 8-way modular connectors, 8 poles .....	145
Figure H.3 – Straight through cord sets with 8-way modular connectors, 4 poles .....	146
Figure I.1 – Stripping the cable jacket .....	149
Figure I.2 – Example of wire preparation for type A cables .....	150
Figure I.3 – 8-way modular plug .....	150



Figure I.4 – Inserting the cable into the connector body .....	151
Figure I.5 – Crimping the connector .....	151
Figure I.6 – Example of a cable preparation for type A wiring.....	152
Figure I.7 – Connector components .....	153
Figure I.8 – Cable preparation .....	153
Figure I.9 – Connector wire gland, nut and shell on the cable .....	153
Figure I.10 – Conductors preparation .....	153
Figure I.11 – Jacket removal.....	154
Figure I.12 – Shield preparation.....	154
Figure I.13 – Conductors preparation.....	154
Figure I.14 – Installing conductors in connector .....	154
Figure I.15 – Assembling the body of the connector.....	155
Figure I.16 – Final assembling .....	155
Figure N.1 – Loop resistance measurement wire to wire .....	166
Figure N.2 – Loop resistance measurement wire 1 to shield.....	166
Figure N.3 – Loop resistance measurement wire 2 to shield.....	166
Figure N.4 – Resistance measurement for detecting wire shorts .....	166
Figure N.5 – Resistance measurement between wire 1 and wire 2 .....	167
Figure N.6 – Validation of the cable DCR.....	168
Figure N.7 – Conclusions for cable open or shorts .....	169
Figure N.8 – Determination of proper cable terminator value.....	170
Figure O.1 – Channel according to ISO/IEC 11801 .....	171
Figure O.2 – End-to-end link .....	172
Table 1 – Basic network characteristics for balanced cabling not based on Ethernet.....	39
Table 2 – Network characteristics for balanced cabling based on Ethernet .....	40
Table 3 – Network characteristics for optical fibre cabling .....	41
Table 4 – Information relevant to copper cable: fixed cables .....	43
Table 5 – Information relevant to copper cable: cords .....	44
Table 6 – Information relevant to optical fibre cables .....	45
Table 7 – Connectors for balanced cabling CPs based on Ethernet .....	47
Table 8 – Connectors for copper cabling CPs not based on Ethernet .....	47
Table 9 – Optical fibre connecting hardware .....	47
Table 10 – Relationship between FOC and fibre types (CP x/y) .....	48
Table 11 – Basic reference implementation formulas .....	50
Table 12 – Enhanced reference implementation formulas .....	51
Table 13 – Correction factor Z for operating temperature above 20 °C .....	52
Table 14 – Equalisation and earthing conductor sizing and length .....	57
Table 15 – Bonding straps cross-section.....	59
Table 16 – Bonding plates surface protection.....	59
Table 17 – Cable circuit types and minimum distances .....	68
Table 18 – Parameters for balanced cables .....	71
Table 19 – Parameters for silica optical fibre cables .....	71

Table 20 – Parameters for POF optical fibre cables .....	71
Table 21 – Parameters for hard clad silica optical fibre cables .....	72
Table 22 – Typical problems in a network with balanced cabling .....	106
Table 23 – Typical problems in a network with optical fibre cabling .....	107
Table B.1 – Example 1 of targeted MICE area .....	114
Table B.2 – Example 2 of targeted MICE area .....	114
Table B.3 – Relationship between electromagnetic disturbance-generating devices and “E” classification .....	116
Table B.4 – Coupling mechanism for some interfering devices .....	117
Table B.5 – MICE definition .....	118
Table D.1 – Conventions for colour code used in the connector table .....	122
Table D.2 – Pair numbers and colour scheme .....	123
Table D.3 – 8-way modular connector .....	124
Table D.4 – M12-4 A-coding connector .....	125
Table D.5 – M12-4 D-coding connector .....	126
Table D.6 – M12-5 A-coding connector .....	127
Table D.7 – M12-5 B-coding connector .....	128
Table D.8 – SubD connector .....	129
Table D.9 – 7/8-16 UN-2B THD / M18 connector .....	130
Table D.10 – Open style connector .....	131
Table D.11 – M12-8 X-coding connector .....	132
Table D.12 – BNC connector .....	133
Table D.13 – TNC connector .....	134
Table F.1 – American wire gauge system and kcmil .....	137
Table G.1 – Copper cabling verification checklist .....	139
Table G.2 – Earthing and bonding measurements checklist .....	141
Table G.3 – Signatures for Table G.1 and Table G.2 checklists .....	141
Table G.4 – Checklist for special checks for non-Ethernet base CPs .....	142
Table G.5 – Signatures for Table G.4 checklist .....	142
Table G.6 – Optical fibre cabling verification checklist .....	143
Table G.7 – Signatures for Table G.6 checklist .....	143
Table H.1 – M12-4 D-coding pin/pair assignment .....	145
Table H.2 – M12-4 D-coding to M12-4 D-coding crossover pin/pair assignment .....	145
Table H.3 – 8-way modular pin/pair assignment .....	146
Table H.4 – 8-way modular crossover pin/pair assignment .....	147
Table H.5 – Connectivity pin assignment .....	147
Table H.6 – M12 to 8-way modular crossover pin pair assignment .....	148
Table J.1 – Transmission requirements for more than 4 connections in a channel .....	156
Table M.1 – Trade names of CPFs and CPs .....	163

## INTRODUCTION

Process and factory automation are increasingly relying on communication networks and fieldbuses that are inherently designed to cope with the specific environmental conditions of the industrial premises. The networks and fieldbuses provide for an effective integration of applications among the several functional units of the plant/factory. One of the benefits of integrating field-generated data with higher-level management systems is to reduce production costs. At the same time, integrated data helps maintain or even increase the quantity and quality of production. A correct network installation is an important prerequisite for communications availability, reliability, and performance. This requires proper consideration of safety and security conditions and environmental aspects such as mechanical, liquid, particulate, climatic, chemicals and electromagnetic interference.

The specifications of these communication networks are provided in the following standards.

ISO/IEC 24702 specifies design of generic telecommunications infrastructures within industrial premises and provides the foundations for some of the transmission performance specifications of this standard. ISO/IEC 24702 specifies only the raw bandwidth capability of a channel; it does not specify useful data transfer rate for a specific network using that channel or expected errors after taking account of interference during the communication process.

IEC 61158 fieldbus standard and IEC 62026-3 and their companion standard IEC 61784-1 and IEC 61784-2 jointly specify several CPs suitable for industrial automation. These CPs specify a raw bandwidth capability and in addition, they specify bit modulation and encoding rules for their fieldbus. Some profiles also specify target levels for useful data transfer rate, and maximum values for errors caused by interference during the communication process.

This standard provides a consistent set of installation rules for industrial premises concerning both generic cabling (of the telecommunication infrastructures) and fieldbuses. In addition, it offers support for the definition and installation of the interfaces between automation island networks and generic cabling. One of the problems it seeks to solve is the situation created when different parts of a large automation site are provided by suppliers that use non-homogeneous installation guidelines having different structures and contents. This lack of consistency greatly increases the potential for errors and mismatch situations liable to compromise the communication system.

This standard was developed by harmonising the approaches of several user groups and industrial consortia.

This standard provides a common point of reference for the installation of the media of most used industrial communication networks for most industrial sites. The standard covers the life cycle of an installation in the following clauses (see the map of the standard in Figure 1):

- Clause 4: Installation planning;
- Clause 5: Installation implementation;
- Clause 6: Installation verification and acceptance test;
- Clause 7: Installation administration;
- Clause 8: Installation maintenance and installation troubleshooting.

The methods described in these clauses are written in such a way as to provide installation guidance for a wide range of technician skills.

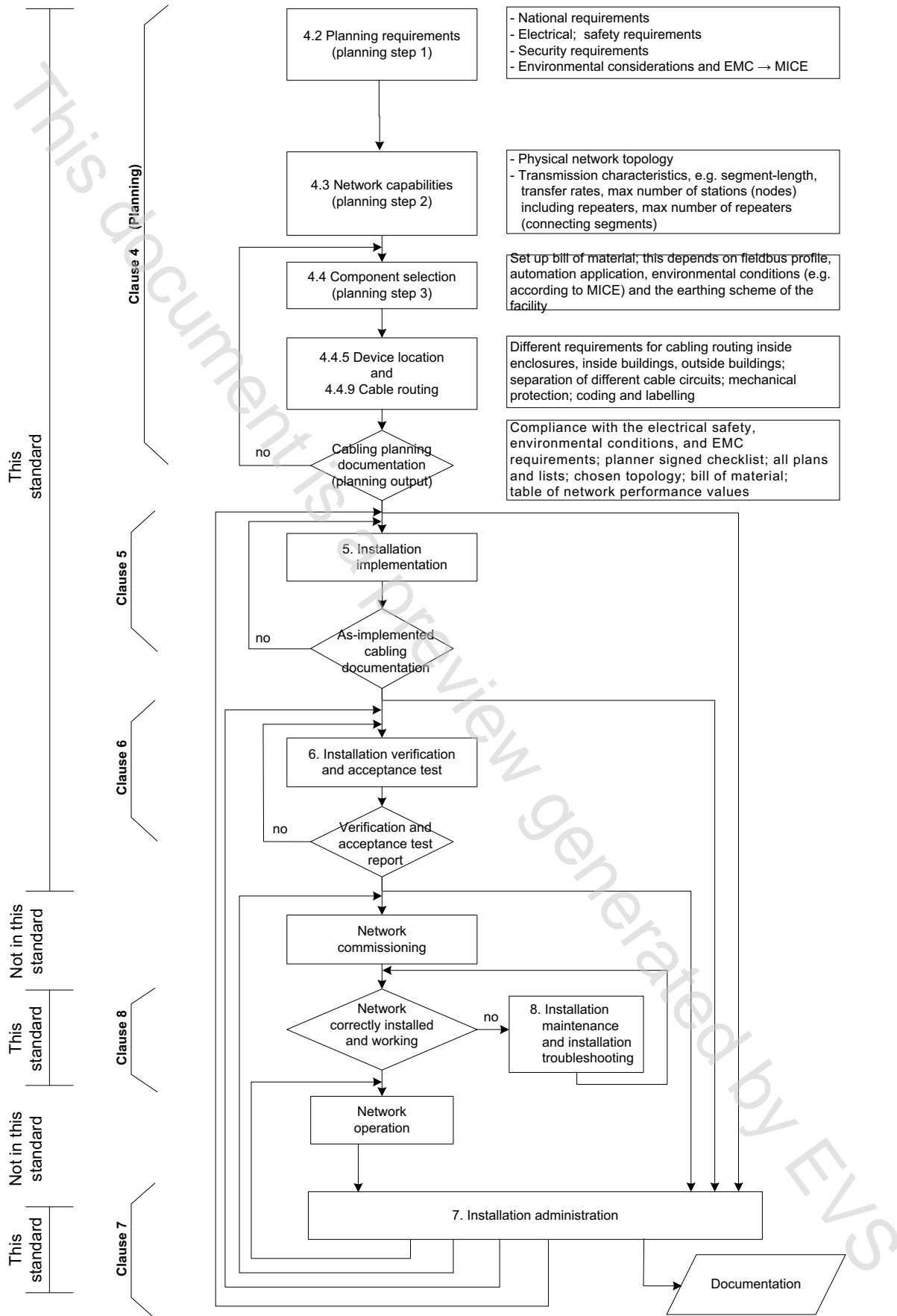


Figure 1 – Industrial network installation life cycle

The installation of a communication system is supported by this standard used in conjunction with the relevant installation profile. The installation profile establishes the technology-specific requirements in terms of which requirements apply as they are in this standard, or which have been extended, modified, or replaced.

For the fieldbuses that are defined in the IEC 61784 series as communication profiles (CPs) of the communication profile families (CPF), the installation is specified in the installation profiles that are available in the IEC 61784-5-n series, where n is the CPF number. IEC 61158-1 describes the relationship between the fieldbus and the CPs and the relevant installation profiles (see Figure 2).

For the installation of generic cabling, this standard is to be used in conjunction with ISO/IEC 14763-2 (see Figure 2).

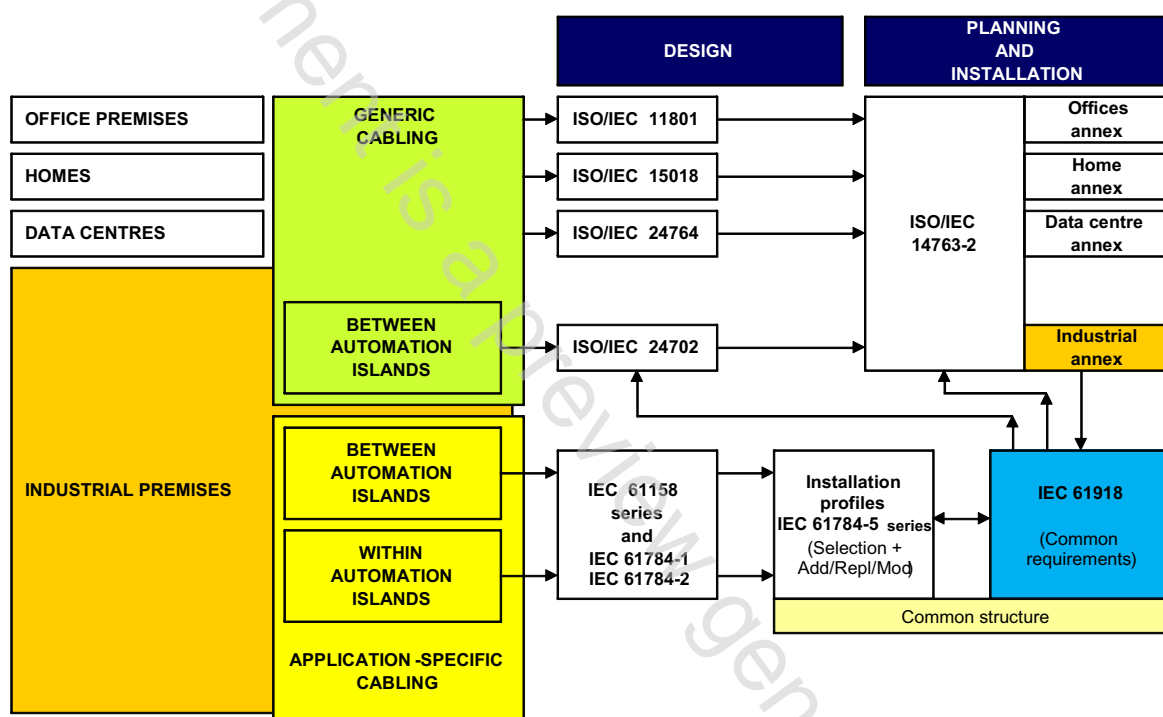


Figure 2 – Standards relationships

One of the advantages of this structure is that the users of a network know which installation requirements are common to most networks and which are specific to a particular network.

Every single plant/factory has its own installation needs in accordance with the specific critical conditions that apply to the specific application. This standard and its companion standards described above provide a set of mandatory installation requirements ("shalls") and a number of recommendations ("shoulds"). It is up to the owner of the specific industrial enterprise to explicitly request that the cabling installation be implemented in accordance with these standards and to list all recommendations that shall be considered as mandatory requirements for the specific case.

## INDUSTRIAL COMMUNICATION NETWORKS –

### Installation of communication networks in industrial premises

#### 1 Scope

This International Standard specifies basic requirements for the installation of media for communication networks in industrial premises and within and between the automation islands, of industrial sites. This standard covers balanced and optical fibre cabling. It also covers the cabling infrastructure for wireless media, but not the wireless media itself. Additional media are covered in the IEC 61784-5 series.

This standard is a companion standard to the communication networks of the industrial automation islands and especially to the communication networks specified in the IEC 61158 series and the IEC 61784 series. In addition, this standard covers:

- the installation of generic telecommunication cabling for industrial premises as specified in ISO/IEC 24702;
- the connection between the generic telecommunications cabling specified in ISO/IEC 24702 and the specific communication cabling of an automation island, where an automation outlet (AO) replaces the telecommunication outlet (TO) of ISO/IEC 24702.

**NOTE** If the interface used at the AO does not conform to that specified for the TO of ISO/IEC 24702, the cabling no longer conforms to ISO/IEC 24702 although certain features, including performance, of generic cabling may be retained.

This standard provides guidelines that cope with the critical aspects of the industrial automation area (safety, security and environmental aspects such as mechanical, liquid, particulate, climatic, chemicals and electromagnetic interference).

This standard does not recognise implementations of power distribution through Ethernet balanced cabling systems that are not specified in IEEE 802.3 and in IEEE 802.3at.

This standard deals with the roles of planner, installer, verifier, and acceptance test personnel, administration and maintenance personnel and specifies the relevant responsibilities and/or gives guidance.

#### 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 60364-1:2005, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

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

IEC 60364-4-44, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*

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 (all parts), *Connectors for electronic equipment*

IEC 60603-7 (all subparts), *Connectors for electronic equipment – Part 7: Detail specification for 8-way, unshielded, free and fixed connectors*

IEC 60757, *Code for designation of colours*

IEC 60793 (all parts), *Optical fibres*

IEC 60793-2-10, *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres*

IEC 60794 (all parts), *Optical fibre cables*

IEC 60807-2, *Rectangular connectors for frequencies below 3 MHz – Part 2: Detail specification for a range of connectors, with assessed quality, with trapezoidal shaped metal shells and round contacts – Fixed solder contact types*

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 60825-2, *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)*

IEC 60950-1, *Information technology equipment – Safety – Part 1: General requirements*

IEC 61076-2-101, *Connectors for electronic equipment – Product requirements - Part 2-101: Circular connectors – Detail specification for M12 connectors with screw-locking*

IEC/PAS 61076-2-109, *Connectors for electronic equipment – Product requirements – Part 2-109: Circular connectors – Detail specification for connectors M12 x 1 with screw-locking, for data transmissions with frequencies up to 500 MHz*

IEC 61076-3-106, *Connectors for electronic equipment – Product requirements – Part 3-106: Rectangular connectors – Detail specification for protective housings for use with 8-way shielded and unshielded connectors for industrial environments incorporating the IEC 60603-7 series interface*

IEC 61076-3-117, *Connectors for electronic equipment – Product requirements – Part 3-117: Rectangular connectors – Detail specification for protective housings for use with 8-way shielded and unshielded connectors for industrial environments incorporating IEC 60603-7 series interface – Variant 14 related to IEC 61076-3-106 – Push-pull coupling*

IEC 61156 (all parts), *Multicore and symmetrical pair/quad cables for digital communications*

IEC 61158 (all parts), *Industrial communication networks – Fieldbus specifications*

IEC 61158-2:\_\_\_\_, *Industrial communication networks – Fieldbus specifications – Part 2: Physical layer specification and service definition*<sup>1</sup>

IEC 61169-8, *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 ohm (type BNC)*

IEC 61753 (all parts), *Fibre optic interconnecting devices and passive components performance standard*

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

IEC 61754-4, *Fibre optic connector interfaces – Part 4: Type SC connector family*

IEC 61754-20, *Fibre optic interconnecting devices and passive components – Fibre optic connector interfaces – Part 20: Type LC connector family*

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

IEC 61754-24, *Fibre optic interconnecting devices and passive components – Fibre optic connector interfaces – Part 24: Type SC-RJ connector family*

IEC 61784 (all parts), *Industrial communication networks – Profiles*

IEC 61784-1, *Industrial communication networks – Profiles – Part 1: Fieldbus profiles*

IEC 61784-2:\_\_\_\_, *Industrial communication networks – Profiles – Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC 8802-3*<sup>2</sup>

IEC 61784-3, *Industrial communication networks – Profiles – Part 3: Functional safety fieldbuses – General rules and profile definitions*

IEC 61784-5 (all subparts), *Industrial communication networks – Profiles – Part 5: Installation of fieldbuses*

IEC 61935-1:2009, *Specification for the testing of balanced and coaxial information technology cabling – Part 1: Installed balanced cabling as specified in ISO/IEC 11801 and related standards*

IEC 61935-2, *Specification for the testing of balanced and coaxial information technology cabling – Part 2: Cords as specified in ISO/IEC 11801 and related standards*

IEC 62026-3, *Low-voltage switchgear and controlgear – Controller-device interfaces (CDIs) – Part 3: DeviceNet*

IEC 62439 (all parts), *Industrial communication networks – High availability automation networks*

IEC 62443 (all parts), *Industrial communication networks – Network and system security*<sup>3</sup>

<sup>1</sup> To be published.

<sup>2</sup> To be published.

<sup>3</sup> Check <http://webstore.iec.ch> for the published parts. Other parts are under consideration.