



SLOVENSKI STANDARD
oSIST prEN 61918:2009
01-december-2009

Industrijska komunikacijska omrežja - Inštalacija komunikacijskih omrežij v industrijskih okoljih

Industrial communication networks - Installation of communication networks in industrial premises

Industrielle Kommunikationsnetze - Installation von Kommunikationsnetzen in Industrieanlagen

Réseaux de communication industriels - Installation des réseaux de communication dans les locaux industriels

iTeh STANDARD PREVIEW
(standards.iteh.ai)
<https://standards.iteh.ai/catalog/standards/sist/81f93984-c896-4383-8632-c925b02c29e5/osist-pr-en-61918-2009>

Ta slovenski standard je istoveten z: prEN 61918:2009

ICS:

25.040.40	Merjenje in krmiljenje industrijskih postopkov	Industrial process measurement and control
35.110	Omreževanje	Networking

oSIST prEN 61918:2009

en,fr,de

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[oSIST prEN 61918:2009](#)

<https://standards.iteh.ai/catalog/standards/sist/81f93984-c896-4383-8632-c925b02c29e5/osist-pren-61918-2009>

**Industrial communication networks -
Installation of communication networks in industrial premises**
(IEC 61918:200X (65C/537/CDV), modified)

Réseaux de communication industriels -
Installation des réseaux de
communication dans les locaux industriels
(CEI 61918:200X (65C/537/CDV),
modifiée)

Industrielle Kommunikationsnetze -
Installation von Kommunikationsnetzen in
Industrieanlagen
(IEC 61918:200X (65C/537/CDV),
modifiziert)

This draft European Standard is submitted to CENELEC members for CENELEC enquiry.
Deadline for CENELEC: 2010-03-19.

The text of this draft consists of the text of IEC 61918:200X(65C/537/CDV) with common modifications prepared by CLC/TC 65CX.

If this draft becomes a European Standard, 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.

This draft European Standard was established by CENELEC 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 Central Secretariat has the same status as the official versions.

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

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.

CENELEC

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

Central Secretariat: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of the future International Standard IEC 61918:200X (65C/537/CDV), prepared by SC 65C, Industrial networks, of IEC TC 65, Industrial-process measurement and control, together with the common modifications prepared by the Technical Committee CENELEC TC 65CX, Fieldbus, is submitted to the CENELEC enquiry.

CLC/TC 65CX note:

According to CLC/TC65CX/SEC/126/REP IEC 61918, Ed. 2, was exempted from CENELEC parallel vote procedure.

Reason for this exception are references to other standards, which differ on IEC- and on CENELEC-level (see TC65CX -Resolution No. 97):

On IEC-level this standard refers to ISO/IEC 14763-2 (standard for the installation of the generic cabling in non-industrial premises).

On European level future EN 61918 has to refer to corresponding European Standards of EN 50174-series (see CLC/TC65CX/SEC/117/REP).

In order to ensure proper references the following common modifications shall be integrated; these have been prepared with the help of the Convenor of IEC/SC 65C, JWG 10, and coordinated with CLC/TC 215.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[osIST prEN 61918:2009](https://standards.iteh.ai/catalog/standards/sist/81f93984-c896-4383-8632-c925b02c29e5/osist-pren-61918-2009)

<https://standards.iteh.ai/catalog/standards/sist/81f93984-c896-4383-8632-c925b02c29e5/osist-pren-61918-2009>

Text of prEN 61918

The text of this draft European Standard consists of the text of the future International Standard IEC 61918:200X (65C/537/CDV) with the following common modifications.

COMMON MODIFICATIONS

• Introduction

Replace the last paragraph 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:

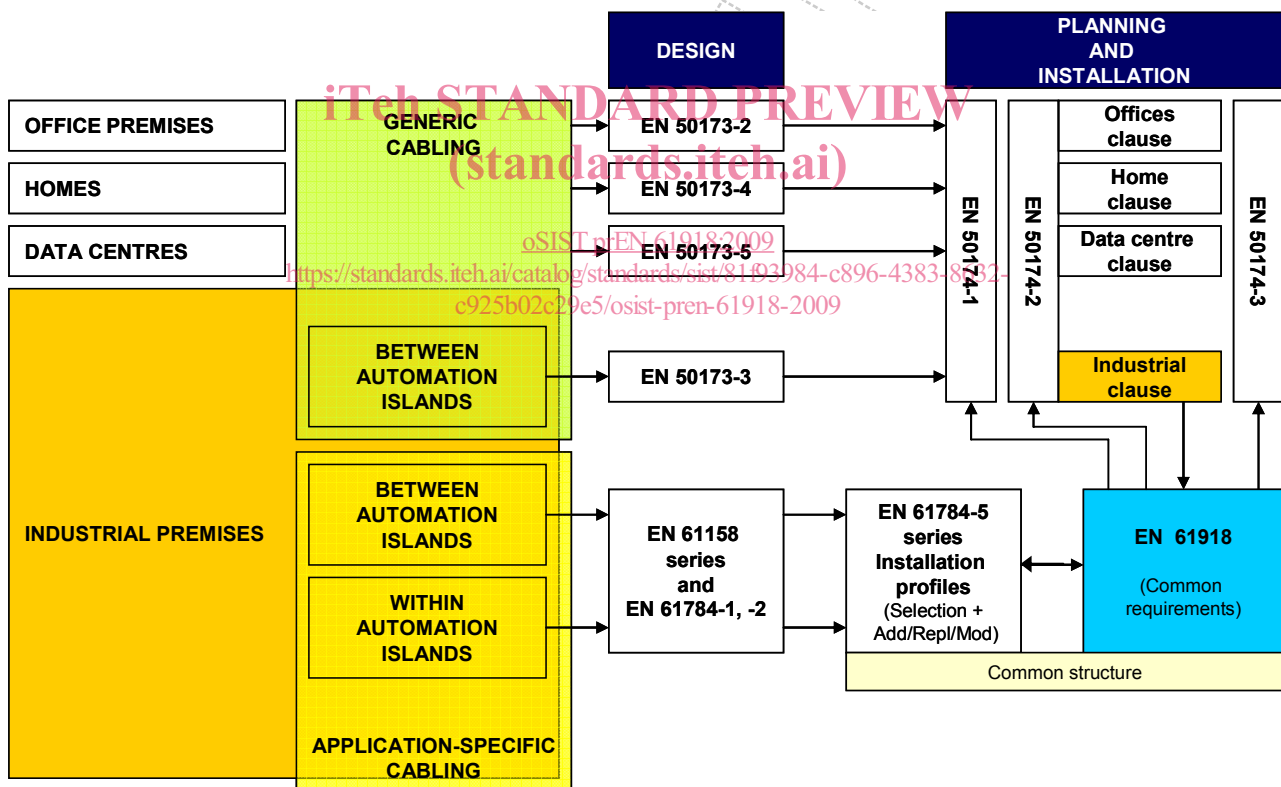


Figure 2 - Network installation: Standards relationships at European level ¹⁾

- 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'.

¹⁾ Editor's note (to be deleted in the final version): Compared to EN 61918:2008 the arrow between EN 61784-5 and EN 61918 has been modified to be bidirectional.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[oSIST prEN 61918:2009](#)

<https://standards.iteh.ai/catalog/standards/sist/81f93984-c896-4383-8632-c925b02c29e5/osist-pren-61918-2009>



65C/537/CDV

COMMITTEE DRAFT FOR VOTE (CDV) PROJET DE COMITÉ POUR VOTE (CDV)

Project number Numéro de projet		IEC 61918/Ed2.0	
IEC/TC or SC: 65C CEI/CE ou SC:		Secretariat / Secrétariat FRANCE	
<input type="checkbox"/> Submitted for parallel voting in CENELEC <input type="checkbox"/> Soumis au vote parallèle au CENELEC	Date of circulation Date de diffusion 2009-05-01	Closing date for voting (Voting mandatory for P-members) Date de clôture du vote (Vote obligatoire pour les membres (P)) 2009-10-02	
	Also of interest to the following committees Intéresse également les comités suivants IEC 57 and ISO TC184/SC5	Supersedes document Remplace le document 65C/515/CD	
Proposed horizontal standard Norme horizontale suggérée <input type="checkbox"/> Other TC/SCs are requested to indicate their interest, if any, in this CDV to the TC/SC secretary Les autres CE/SC sont requis d'indiquer leur intérêt, si nécessaire, dans ce CDV à l'intention du secrétaire du CE/SC			
Functions concerned Fonctions concernées			
<input type="checkbox"/> Safety Sécurité	<input type="checkbox"/> EMC CEM	<input type="checkbox"/> Environment Environnement	<input type="checkbox"/> Quality assurance Assurance qualité

CE DOCUMENT EST TOUJOURS À L'ÉTUDE ET SUSCEPTIBLE DE MODIFICATION. IL NE PEUT SERVIR DE RÉFÉRENCE.

LES RÉCIPIENDAIRES DU PRÉSENT DOCUMENT SONT INVITÉS À PRÉSENTER, AVEC LEURS OBSERVATIONS, LA NOTIFICATION DES DROITS DE PROPRIÉTÉ DONT ILS AURAIENT ÉVENTUELLEMENT CONNAISSANCE ET À FOURNIR UNE DOCUMENTATION EXPLICATIVE.

THIS DOCUMENT IS STILL UNDER STUDY AND SUBJECT TO CHANGE. IT SHOULD NOT BE USED FOR REFERENCE PURPOSES.

RECIPIENTS OF THIS DOCUMENT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

(standards.iteh.ai)

Title : IEC 61918: Industrial communication networks – Installation of communication networks in industrial premises

Introductory note

Editor's notes – formatted like this one – are included in the document to inform CD reviewers about specific questions and advices. These editor's notes will not be part of the final International Standard.

This document is circulated for vote with comments. Comments will be solved during SC65C/JWG10 meeting to be held in Berlin (Germany) on November 9th – 13th, 2009.

Copyright © 2009 International Electrotechnical Commission, IEC. All rights reserved. It is permitted to download this electronic file, to make a copy and to print out the content for the sole purpose of preparing National Committee positions. You may not copy or "mirror" the file or printed version of the document, or any part of it, for any other purpose without permission in writing from IEC.

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	26
3.3 Conventions for installation profiles	28
4 Installation planning	28
4.1 Introduction	28
4.1.1 Objective	28
4.1.2 Cabling in industrial premises	28
4.1.3 The planning process	30
4.1.4 Specific requirements for CPs	31
4.1.5 Specific requirements for generic cabling in accordance with ISO/IEC 24702	31
4.2 Planning requirements.....	31
4.2.1 Safety.....	31
4.2.2 Security.....	32
4.2.3 Environmental considerations and EMC.....	32
4.2.4 Specific requirements for generic cabling in accordance with ISO/IEC 24702	34
4.3 Network capabilities	34
4.3.1 Network topology.....	34
4.3.2 Network characteristics.....	36
4.4 Selection and use of cabling components	39
4.4.1 Cable selection.....	39
4.4.2 Connecting hardware selection.....	43
4.4.3 Connections within a channel/permanent link	44
4.4.4 Terminators	50
4.4.5 Device location and connection	50
4.4.6 Coding and labelling.....	50
4.4.7 Earthing and bonding of equipment and devices and shielded cabling	51
4.4.8 Storage and transportation of cables	58
4.4.9 Routing of cables.....	58
4.4.10 Separation of circuits.....	60
4.4.11 Mechanical protection of cabling components.....	61
4.4.12 Installation in special areas	62
4.5 Cabling planning documentation.....	62
4.5.1 Common description.....	62
4.5.2 Cabling planning documentation for CPs	62
4.5.3 Network certification documentation	63
4.5.4 Cabling planning documentation for generic cabling in accordance with ISO/IEC 24702	63
4.6 Verification of cabling planning specification	63
5 Installation implementation	63
5.1 General requirements.....	63

5.1.1	Common description	63
5.1.2	Installation of CPs	63
5.1.3	Installation of generic cabling in industrial premises	63
5.2	Cable installation.....	63
5.2.1	General requirements for all cabling types	63
5.2.2	Installation and routing	69
5.2.3	Specific requirements for CPs	70
5.2.4	Specific requirements for wireless installation.....	71
5.2.5	Specific requirements for generic cabling in accordance with ISO/IEC 24702	71
5.3	Connector installation.....	71
5.3.1	Common description	71
5.3.2	Shielded connectors	71
5.3.3	Unshielded connectors	72
5.3.4	Specific requirements for CPs	72
5.3.5	Specific requirements for wireless installation.....	72
5.3.6	Specific requirements for generic cabling in accordance with ISO/IEC 24702	72
5.4	Terminator installation	72
5.4.1	Common description	72
5.4.2	Specific requirements for CPs	72
5.5	Device installation	72
5.5.1	Common description	72
5.5.2	Specific requirements for CPs	72
5.6	Coding and labelling.....	73
5.6.1	Common description	73
5.6.2	Specific requirements for CPs	73
5.7	Earthing and bonding of equipment and devices and shield cabling.....	73
5.7.1	Common description	73
5.7.2	Bonding and earthing of enclosures and pathways	73
5.7.3	Earthing methods	74
5.7.4	Shield earthing methods	76
5.7.5	Specific requirements for CPs	78
5.7.6	Specific requirements for generic cabling in accordance with ISO/IEC 24702	78
5.8	As-implemented cabling documentation.....	78
6	Installation verification and installation acceptance test	79
6.1	Introduction	79
6.2	Installation verification.....	79
6.2.1	General	79
6.2.2	Verification according to cabling planning documentation	79
6.2.3	Verification of earthing and bonding	81
6.2.4	Verification of shield earthing	82
6.2.5	Verification of cabling system	82
6.2.6	Cable selection verification.....	82
6.2.7	Connector verification.....	82
6.2.8	Connection verification	83
6.2.9	Terminators verification	84
6.2.10	Coding and labelling verification	85
6.2.11	Verification report	85

6.3	Installation acceptance test	85
6.3.1	General	85
6.3.2	Acceptance test of Ethernet based cabling	87
6.3.3	Acceptance test of non Ethernet based cabling	89
6.3.4	Specific requirements for wireless installation.....	90
6.3.5	Acceptance test report.....	90
7	Installation administration.....	90
7.1	General.....	90
7.2	Fields covered by the administration	90
7.3	Basic principles for the administration system	91
7.4	Working procedures	91
7.5	Device location labelling.....	91
7.6	Component cabling labelling.....	92
7.7	Documentation	93
7.8	Specific requirements for administration.....	93
8	Installation maintenance and installation troubleshooting	93
8.1	General.....	93
8.2	Maintenance.....	94
8.2.1	Scheduled maintenance	94
8.2.2	Condition-based maintenance	95
8.2.3	Corrective maintenance.....	96
8.3	Troubleshooting.....	96
8.3.1	General description.....	96
8.3.2	Evaluation of the problem.....	96
8.3.3	Typical problems	97
8.3.4	Troubleshooting procedure.....	99
8.3.5	Simplified troubleshooting procedure.....	100
8.4	Specific requirements for maintenance and troubleshooting	101
Annex A (informative)	Introduction to generic cabling for industrial premises	102
Annex B (informative)	MICE description methodology	103
B.1	General.....	103
B.2	Introduction to MICE.....	103
B.3	Examples of use of the MICE concept	104
B.3.1	Common description.....	104
B.3.2	Examples of mitigation	105
B.3.2.1	Example 1	105
B.3.2.2	Example 2	105
B.4	Determining E classification	106
B.5	The MICE table	108
Annex C (informative)	Network topologies.....	111
C.1	Common description.....	111
C.2	Total cable demand	111
C.3	Maximum cable segment length.....	111
C.4	Maximum network length	111
C.5	Fault tolerance	111
C.5.1	General.....	111
C.5.2	Use of redundancy	111
C.5.3	Failure analysis for networks with redundancy.....	111

C.6 Network access for diagnosis convenience	112
C.7 Maintainability and on-line additions	112
Annex D (informative) Connector table.....	113
Annex E (informative) Power networks with respect to electromagnetic interference – TN-C and TN-S approaches	126
Annex F (informative) Conversion table mm ² to AWG.....	128
Annex G (informative) Installed cabling verification checklists.....	129
G.1 Introduction	129
G.2 Copper cabling verification checklist.....	129
G.3 Optical fibre cabling verification checklist	132
Annex H (normative) Cord sets	133
H.1 General	133
H.2 Constructing cord sets.....	133
H.2.1 Straight through cord sets with M12-4 D-coding connectors	133
H.2.2 Crossover cord sets with M12-4 D-coding connectors.....	134
H.2.3 Straight through cord sets with 8-way modular connectors	134
H.2.4 Crossover cord sets with 8-way modular connectors	135
H.2.5 Straight conversion from one connector family to another.....	136
H.2.6 Crossover conversion from one connector family to another.....	136
Annex I (informative) Guidance for terminating cable ends	138
I.1 Introduction	138
I.2 Guidance for terminating shielded twisted pair cable ends for 8-way modular plugs.....	138
I.3 Guidance for terminating unshielded twisted pair cable ends for 8-way modular plugs	140
I.4 Guidance for M12-4 D-coding connector installation.....	141
I.5 Guidance for terminating optical fibre cable ends	144
Annex J (informative) Recommendations for bulkhead connection performance and channel performance with more than 4 connections in the channel.....	145
J.1 Introduction	145
J.2 Recommendations.....	145
Annex K (informative) Fieldbus data transfer testing	146
K.1 Background	146
K.2 Allowable error rates for control systems	146
K.2.1 Bit errors	146
K.2.2 Burst errors	146
K.3 Testing channel performance	147
K.4 Testing cable parameters	147
K.4.1 General	147
K.4.2 Generic cable testing.....	147
K.4.3 Fieldbus cable testing.....	147
K.5 Testing fieldbus data rate performance.....	148
K.5.1 General	148
K.5.2 Fieldbus test	148
K.5.3 Planning for fieldbus data rate testing	148
K.5.4 Fieldbus data rate test reporting template	149
K.5.5 Values for acceptable fieldbus performance	149

Annex L (informative) Communication network installation work responsibility	150
L.1 Introduction	150
L.2 Installation work responsibility	150
L.3 Installation work responsibility table	150
Annex M (informative) Trade names of communication profiles	151
Annex N (informative) Validation measurements	153
N.1 General	153
N.2 DCR measurements	153
N.2.1 Purpose of test	153
N.2.2 Assumptions	153
N.2.3 Measurements	153
N.2.4 Calculations	155
N.2.4.1 Calculated DCR values for wires and shield	155
N.2.4.2 Derived DCR values for wires and shield	155
N.2.5 Measurement results	155
N.2.5.1 Validation of the cable DCR	155
N.2.5.2 Conclusions for cable open or shorts	156
N.2.5.3 Determination of proper cable terminator value	157
Bibliography	159
Figure 1 – Industrial network installation life cycle	13
Figure 2 – Standards relationships	14
Figure 3 – Structure of generic cabling connected to an automation island	28
Figure 4 – Automation island cabling attached to elements of generic cabling	29
Figure 5 – Automation islands	29
Figure 6 – Automation island network external connections	30
Figure 7 – How to meet environmental conditions	33
Figure 8 – How enhancement, isolation and separation work together	34
Figure 9 – Basic physical topologies for passive networks	35
Figure 10 – Basic physical topologies for active networks	35
Figure 11 – Example of combination of basic topologies	35
Figure 12 – Basic reference implementation model	45
Figure 13 – Enhanced reference implementation model	47
Figure 14 – Selection of the earthing and bonding systems	53
Figure 15 – Wiring for bonding and earthing in a mesh equipotential configuration	55
Figure 16 – Wiring of the earths in a star earth configuration	56
Figure 17 – Schematic diagram of a field device with direct earthing	57
Figure 18 – Schematic diagram of a field device with parallel RC circuit earthing	57
Figure 19 – Insert edge protector	65
Figure 20 – Use an uncoiling device and avoid forming loop	65
Figure 21 – Avoid torsion	66
Figure 22 – Maintain minimum bending radius	66
Figure 23 – Do not pull by the individual wires	67
Figure 24 – Use cable clamps with a large (wide) surface	67
Figure 25 – Cable gland with bending protection	67

Figure 26 – Spiral tube	68
Figure 27 – Separate cable pathways	70
Figure 28 – Use of flexible bonding straps at movable metallic pathways	74
Figure 29 – Surface preparation for electromechanical earth and bonding connections	74
Figure 30 – Example of isolated bus bar	76
Figure 31 – Example of isolator for mounting DIN rails	76
Figure 32 – Parallel RC shield earthing	76
Figure 33 – Direct shield earthing	77
Figure 34 – Examples for shielding application	77
Figure 35 – First example of derivatives of shield earthing	78
Figure 36 – Second example of derivatives of shield earthing	78
Figure 37 – Installation verification process	80
Figure 38 – Test of earthing connections	81
Figure 39 – 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	84
Figure 40 – Two pair 8-way modular connector	84
Figure 41 – Transposed pairs, split pairs and reversed pair	84
Figure 42 – Validation process	86
Figure 43 – Schematic representation of the channel	87
Figure 44 – Schematic representation of the permanent link	87
Figure 45 – Communication network maintenance	95
Figure 46 – Troubleshooting procedure	100
Figure 47 – Fault detection without special tools	101
Figure B.1 – MICE classifications	103
Figure B.2 – Example MICE classifications within a facility	104
Figure B.3 – Enhancement, isolation and separation	104
Figure B.4 – Example 1 of mitigation	105
Figure B.5 – Example 2 of mitigation	106
Figure B.6 – Frequency range of electromagnetic disturbance from common industrial devices	106
Figure B.7 – Example of a general guidance for separation versus EFT value	108
Figure E.1 – Four-wire power network (TN-C)	126
Figure E.2 – Five wire power network (TN-S)	127
Figure H.1 – Straight through cord sets with M12-4 D-coding connectors	133
Figure H.2 – Straight through cord sets with 8-way modular connectors, 8 poles	134
Figure H.3 – Straight through cord sets with 8-way modular connectors, 4 poles	135
Figure I.1 – Stripping the cable jacket	138
Figure I.2 – Example of wire preparation for type A cables	139
Figure I.3 – 8-way modular plug	139
Figure I.4 – Inserting the cable into the connector body	140
Figure I.5 – Crimping the connector	140
Figure I.6 – Example of a cable preparation for type A wiring	141
Figure I.7 – Connector components	142
Figure I.8 – Cable preparation	142

Figure I.9 – Connector wire gland, nut and shell on the cable	142
Figure I.10 – Conductors preparation	142
Figure I.11 – Jacket removal	142
Figure I.12 – Shield preparation	143
Figure I.13 – Conductors preparation	143
Figure I.14 – Installing conductors in connector	143
Figure I.15 – Assembling the body of the connector	143
Figure I.16 – Final assembling	144
Figure N.1 – Loop resistance measurement wire to wire	153
Figure N.2 – Loop resistance measurement wire 1 to shield	154
Figure N.3 – Loop resistance measurement wire 2 to shield	154
Figure N.4 – Resistance measurement for detecting wire shorts	154
Figure N.5 – Resistance measurement between wire 1 and wire 2	155
Figure N.6 – Validation of the cable DCR	156
Figure N.7 – Conclusions for cable open or shorts	157
Figure N.8 – Determination of proper cable terminator value	158
Table 1 – Basic network characteristics for balanced cabling not based on Ethernet	36
Table 2 – Network characteristics for balanced cabling based on Ethernet	37
Table 3 – Network characteristics for optical fibre cabling	38
Table 4 – Information relevant to copper cable fixed cables	40
Table 5 – Information relevant to copper cable: cords	40
Table 6 – Information relevant to optical fibre cables	41
Table 7 – Connectors for balanced cabling CPs based on Ethernet	43
Table 8 – Connectors for copper cabling CPs not based on Ethernet	43
Table 9 – Optical fibre connecting hardware	44
Table 10 – Relationship between FOC and fibre types (CP x/y)	44
Table 11 – Basic reference implementation equations	46
Table 12 – Enhanced reference implementation equations	47
Table 13 – Correction factor Z for operating temperature above 20°C	48
Table 14 – Equalisation and earthing conductor sizing and length	52
Table 15 – Bonding straps cross-section	54
Table 16 – Bonding plates surface protection	54
Table 17 – Cable circuit types and minimum distances	61
Table 18 – Parameters for balanced cables	64
Table 19 – Parameters for silica optical fibre cables	64
Table 20 – Parameters for POF optical fibre cables	64
Table 21 – Parameters for hard cladded silica optical fibre cables	64
Table 22 – Typical problems in a network with balanced cabling	97
Table 23 – Typical problems in a network with optical fibre cabling	98
Table B.1 – Example 1 of targeted MICE area	105
Table B.2 – Example 2 of targeted MICE area	105
Table B.3 – Relationship between electromagnetic disturbance generating devices and “E” classification	107

Table B.4 – Coupling mechanism for each of the interfering devices	107
Table B.5 – MICE definition	109
Table D.1 – Conventions for colour code used in the connector table	113
Table D.2 – 8-way modular connector	115
Table D.3 – M12-4 A-coding connector	116
Table D.4 – M12-4 D-coding connector	117
Table D.5 – M12-5 A-coding connector	118
Table D.6 – M12-5 B-coding connector	119
Table D.7 – SubD connector	120
Table D.8 – M18 connector	121
Table D.9 – Open style connector	122
Table D.10 – BNC connector	123
Table D.11 – TNC connector	124
Table D.12 – Pair numbers and colour scheme	125
Table F.1 – Approximate conversion table for commonly used wire gauge	128
Table G.1 – Copper cabling verification checklist	129
Table G.2 – Earthing and bonding measurements checklist	130
Table G.3 – Signatures for Table G.1 and Table G.2 checklists	130
Table G.4 – Checklist for special checks for non-Ethernet-based CPs	131
Table G.5 – Signatures for Table G.4 checklist	131
Table G.6 – Optical fibre cabling verification checklist	132
Table G.7 – Signatures for Table G.6 checklist	132
Table H.1 – M12-4 D-coding pin/pair assignment	134
Table H.2 – M12-4 D-coding to M12-4 D-coding crossover pin/pair assignment	134
Table H.3 – 8-way modular pin/pair assignment	135
Table H.4 – 8-way modular crossover pin/pair assignment	136
Table H.5 – Connectivity pin assignment	136
Table H.6 – M12 to 8-way modular crossover pin pair assignment	137
Table J.1 – Transmission requirements for more than 4 connections in a channel	145
Table M.1 – Trade names of CPFs and CPs	151