



DPC: 23 / 30474635 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

Date: 01 June 2023

Origin: International

Latest date for receipt of comments: 19 July 2023

Project No. 2023/01130

Responsible committee: GEL/65/3 Industrial Networks

Interested committees:

Title: Draft BS EN 62657-2 ED 4 Industrial networks - Coexistence of wireless systems

Part 2: Coexistence management

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

- i) has any issues related to 3rd party IPR, patent or copyright
- ii) affects other national standard(s)
- iii) requires additional national guidance or information

**WARNING: THIS IS A DRAFT AND MUST NOT BE REGARDED OR USED AS A BRITISH STANDARD.
THIS DRAFT IS NOT CURRENT BEYOND 19 July 2023**

This draft is issued to allow comments from interested parties; all comments will be given consideration prior to publication. No acknowledgement will normally be sent. **See overleaf for information on the submission of comments.**

No copying is allowed, in any form, without prior written permission from BSI except as permitted under the Copyright, Designs and Patent Act 1988 or for circulation within a nominating organization for briefing purposes. Electronic circulation is limited to dissemination by e-mail within such an organization by committee members.

Further copies of this draft may be purchased from BSI Shop <http://shop.bsigroup.com> or from BSI Customer Services, Tel: +44(0) 20 8996 9001 or email cservices@bsigroup.com. British, International and foreign standards are also available from BSI Customer Services.

Information on the co-operating organizations represented on the committees referenced above may be obtained from <http://standardsdevelopment.bsigroup.com>

Responsible Committee Secretary: Ms Charmaine Mukherjee (BSI)

Direct tel:

E-mail: charmaine.mukherjee@bsigroup.com

Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
------------------	------------------------

1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

PROJECT NUMBER: IEC 62657-2 ED4	
DATE OF CIRCULATION: 2023-05-26	CLOSING DATE FOR COMMENTS: 2023-08-18
SUPERSEDES DOCUMENTS: 65C/1248/RR	

IEC SC 65C : INDUSTRIAL NETWORKS	
SECRETARIAT: France	SECRETARY: Ms Valérie DEMASSIEUX
OF INTEREST TO THE FOLLOWING COMMITTEES: SC 3D	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY	

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.

Recipients of this document are invited to submit, with their comments, notification of any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "In Some Countries" clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

TITLE:
Industrial networks - Coexistence of wireless systems - Part 2: Coexistence management

NOTE FROM TC/SC OFFICERS:

NC comments on this CD will be addressed during the next SC65C/WG17 virtual meeting on August 29th, 2023. Meeting details will be sent at a later date by the convenor.

CONTENTS

1		
2		
3	FOREWORD.....	7
4	INTRODUCTION.....	9
5	1 Scope.....	11
6	2 Normative references	11
7	3 Terms, definitions, abbreviated terms and conventions	12
8	3.1 Terms and definitions.....	12
9	3.2 Abbreviated terms.....	27
10	3.3 Conventions.....	28
11	4 Coexistence concept in industrial automation	28
12	4.1 Overview.....	28
13	4.2 Objective	30
14	4.3 Necessity to implement a coexistence management.....	32
15	4.4 Interference potential.....	33
16	4.5 Ancillary conditions	35
17	4.6 Requirements to wireless devices for support of coexistence management	36
18	4.7 Concepts	36
19	4.7.1 Manual coexistence management.....	36
20	4.7.2 Automated non-collaborative coexistence management	37
21	4.7.3 Automated collaborative coexistence management	37
22	4.8 Best practices to achieve coexistence.....	38
23	4.9 Coexistence conceptual model.....	40
24	4.10 Coexistence management and selection of a wireless solution.....	42
25	4.11 Coexistence management system	44
26	5 Coexistence management parameters	44
27	5.1 General.....	44
28	5.1.1 Definition and usage of parameters	44
29	5.1.2 Physical link	44
30	5.2 Adjacent channel selectivity	45
31	5.3 Antenna gain	45
32	5.4 Antenna radiation pattern.....	45
33	5.5 Antenna type	45
34	5.6 Communication availability.....	46
35	5.7 Communication reliability	46
36	5.8 Bit rate of physical link.....	46
37	5.9 Blocked frequency list.....	46
38	5.10 Centre frequency	46
39	5.11 Area of operation	47
40	5.12 Communication load	47
41	5.13 Cut-off frequency	49
42	5.14 Data throughput.....	50
43	5.15 Distance between wireless devices	50
44	5.16 Duty cycle	51
45	5.17 Dwell time	53
46	5.18 Equivalent isotropic radiated power.....	54
47	5.19 Equivalent radiated power.....	54

48	5.20	Frequency band	54
49	5.21	Frequency bandwidth	54
50	5.22	Frequency channel	55
51	5.23	Frequency hopping sequence	55
52	5.24	Future expansion plan	56
53	5.25	Geographical dimension of the plant	56
54	5.26	Infrastructure device	56
55	5.27	Initiation of data transmission	56
56	5.28	Interference type	56
57	5.29	Intervisibility	57
58	5.30	ISM application	57
59	5.31	Length of user data per transfer interval	57
60	5.32	Limitation from neighbours of the plant	57
61	5.33	Maximum number of retransmissions	57
62	5.34	Mechanism for adaptivity	58
63	5.35	Medium access control mechanism	58
64	5.36	Medium utilization factor	58
65	5.37	Message	59
66	5.38	Modulation	59
67	5.39	Natural environmental condition	59
68	5.40	Network topology	59
69	5.41	Number of consecutive lost messages	60
70	5.42	Object movement	60
71	5.43	Operating time between failures	60
72	5.44	Message loss ratio	60
73	5.45	Position of wireless devices	61
74	5.46	Power spectral density	61
75	5.47	Purpose of the automation application	62
76	5.48	Receiver blocking	62
77	5.49	Receiver maximum input level	62
78	5.50	Receiver sensitivity	62
79	5.51	Regional radio regulations	62
80	5.52	Relative movement	63
81	5.53	Response time	63
82	5.54	Security level	63
83	5.55	Spatial coverage of the wireless communication system	64
84	5.56	Spatial extent of the application	64
85	5.57	Spurious response	64
86	5.58	Survival time	64
87	5.59	Total radiated power	64
88	5.60	Transfer interval	64
89	5.61	Transmission gap	65
90	5.62	Transmission time	66
91	5.63	Transmitter output power	69
92	5.64	Transmitter sequence	69
93	5.65	Transmitter spectral mask	71
94	5.66	Update time	71
95	5.67	Wireless device density	72
96	5.68	Wireless device type information	72

97	5.69	Wireless communication solution density	73
98	5.70	Wireless technology or standard	73
99	6	Coexistence management information structures	73
100	6.1	General.....	73
101	6.2	General plant characteristic	75
102	6.2.1	General	75
103	6.2.2	General plant characteristic	75
104	6.2.3	Passive environmental influences	76
105	6.2.4	Active environmental influences.....	76
106	6.3	Application communication requirements	77
107	6.3.1	Overview	77
108	6.3.2	Requirements influencing the characteristic of wireless solutions	78
109	6.3.3	Performance requirements.....	79
110	6.4	Wireless system type and wireless device type	79
111	6.4.1	Overview	79
112	6.4.2	Wireless system type.....	80
113	6.4.3	Wireless device type.....	80
114	6.5	Wireless solution	83
115	6.5.1	Overview	83
116	6.5.2	Wireless system solution	83
117	6.5.3	Wireless device solution	84
118	6.6	Application related characteristic parameters	85
119	7	Coexistence management process	87
120	7.1	General.....	87
121	7.1.1	Overview	87
122	7.1.2	Documentation	87
123	7.1.3	Suitable documentation method.....	89
124	7.1.4	Application of tools	89
125	7.2	Establishment of a coexistence management system	89
126	7.2.1	Nomination of a coexistence manager	89
127	7.2.2	Responsibility of a coexistence manager	90
128	7.2.3	Support by wireless experts.....	90
129	7.2.4	Training	91
130	7.3	Maintaining coexistence management system.....	91
131	7.4	Phases of a coexistence management process	91
132	7.4.1	Investigation phase.....	91
133	7.4.2	Planning phase.....	94
134	7.4.3	Implementation phase.....	96
135	7.4.4	Operation phase	97
136	8	Coexistence parameter templates.....	99
137	Annex A (normative)	Parameter usage in IEC 62657 series	106
138	A.1	General.....	106
139	A.1	Outline of IEC 62657 series	106
140	A.2	Parameter usage in coexistence management process in IEC 62657-2.....	106
141	A.3	Parameters usage among IEC 62657 series.....	109
142	Bibliography		112
143			
144	Figure 1 – Issues of consideration		

145	Figure 2 – Applications using frequency spectrum	31
146	Figure 3 – Progression of expense to achieve coexistence corresponding to the	
147	application classes	36
148	Figure 4 – Separation of wireless systems according to frequency and time	39
149	Figure 5 – Coexistence conceptual model.....	41
150	Figure 6 – Flow chart of the coexistence conceptual model.....	42
151	Figure 7 – Selection of a wireless system in the coexistence management process	43
152	Figure 8 – Communication load in case of two wireless devices	48
153	Figure 9 – Communication load in the case of several wireless devices	49
154	Figure 10 – Cut-off frequencies derived from maximum power level	50
155	Figure 11 – Distance of the wireless devices	51
156	Figure 12 – Duty cycle	52
157	Figure 13 – Maximum dwell time	53
158	Figure 14 – Power spectral density of an IEEE 802.15.4 system	61
159	Figure 15 – Communication cycle, application event interval and machine cycle	65
160	Figure 16 – Transmission gap.....	66
161	Figure 17 – Example of the density functions of transmission time	67
162	Figure 18 – Example of the distribution functions of transmission time	68
163	Figure 19 – Transmitter sequence.....	70
164	Figure 20 – Transmitter spectral mask of an IEEE 802.15.4 system	71
165	Figure 21 – Example of distribution functions of the update time	72
166	Figure 22 – Principle for use of coexistence parameters	75
167	Figure 23 – Parameters to describe the general plant characteristic	75
168	Figure 24 – Parameters to describe application communication requirements	78
169	Figure 25 – Parameters to describe wireless system type and device type.....	79
170	Figure 26 – Example of power spectral density and transmitter spectral mask	81
171	Figure 27 – Example of medium utilization in time and frequency.....	82
172	Figure 28 – Parameters to describe a wireless communication solution	83
173	Figure 29 – Planning of a wireless system in the coexistence management process	95
174	Figure 30 – Implementation and operation of a wireless system in the coexistence	
175	management process.....	98
176	Figure A.1 – Usage of parameters in IEC 62657-2	107
177	Figure A.2 – Parameter usage among IEC 62657 series	110
178		
179	Table 1 – Example of a classification of application communication requirements	30
180	Table 2 – Application profile dependent observation time values.....	52
181	Table 3 – Parameter options for frequency channel	55
182	Table 4 – Hierarchy of the characteristics	74
183	Table 5 – List of parameters used to describe the general plant characteristic	76
184	Table 6 – List of parameters used to describe the passive environmental influences.....	76
185	Table 7 – List of parameters used to describe the active environmental influences	76
186	Table 8 – List of parameters used to describe the interference type	77
187	Table 9 – List of parameters used to describe the requirements influencing the	
188	characteristic of wireless solutions.....	78

189	Table 10 – List of characteristic parameters.....	79
190	Table 11 – List of parameters used to describe the wireless system type.....	80
191	Table 12 – List of parameters used to describe the transmitter of a wireless device	
192	type 82	
193	Table 13 – List of parameters used to describe the receiver of a wireless device type	83
194	Table 14 – List of parameters used to describe a wireless solution	84
195	Table 15 – List of general parameters used to describe the wireless device solution.....	84
196	Table 16 – List of parameters used to describe the transmitter of a wireless device	
197	solution.....	85
198	Table 17 – List of parameters used to describe the receiver of a wireless device	
199	solution.....	85
200	Table 18 – List of relevant characteristic parameters of wireless solutions	86
201	Table 19 – List of relevant statistical values of characteristic parameters.....	86
202	Table 20 – Template used to describe the general plant characteristic.....	100
203	Table 21 – Template used to describe the application communication requirements	101
204	Table 22 – Template used to describe the wireless system type	102
205	Table 23 – Template used to describe a wireless device type	102
206	Table 24 – Template used to describe the wireless system solution.....	103
207	Table 25 – Template used to describe a wireless device solution.....	104
208	Table 26 – Template used to describe the relevant characteristic parameters of	
209	wireless solutions	104
210	Table 27 – Template used to describe the relevant statistical values of characteristic	
211	parameters	105
212	Table 28 – Template used to describe an interference type	105
213	Table A.1 – Example for parameters usage in coexistence management process	108
214		
215		

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL NETWORKS –
COEXISTENCE OF WIRELESS SYSTEMS –****Part 2: Coexistence management****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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62657-2 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2022. This edition constitutes a technical revision.

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

- a) alignment of some definitions and specifications of coexistence parameters in order to facilitate their future inclusion in the IEC Common Data Dictionary (IEC CDD) maintained by the IEC;

b) alignment of some definitions and specifications to be consistent to the new Part 3 and Part 4.

c) Edition 3 of IEC 62657-2 was published in June 2022. Some comments were made in the last development stages of this document asking for explanations on how the parts of the IEC 62657 series were structured and how they were related to each other. Resolution of these comments was deferred until a next edition, which means this edition.

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

Draft	Report on voting
65C/XX/FDIS	65C/XX/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all the parts of the IEC 62657 series, under the general title *Industrial networks – Coexistence of wireless systems*, 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 website under 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.

IMPORTANT – The "colour inside" logo on the cover page of this document 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

The overall market for wireless communication solutions spans a range of diverse applications, with differing performance and functional requirements. Within this overall market, the industrial automation domain could include:

- process automation, covering for example the following industry branches:
 - oil and gas, refining,
 - chemical,
 - pharmaceutical,
 - mining,
 - pulp & paper,
 - water & wastewater,
 - steel,
- electric power such as:
 - power generation (for example wind turbine),
 - power transmission and distribution (grid),
- factory automation, covering for example the following industry branches:
 - food and beverage,
 - automotive,
 - machinery,
 - semiconductor.

Industrial automation requirements for wireless communication systems are different from those of, for example, the telecommunications, commercial and consumer markets. These industrial automation requirements are identified and provided in IEC 62657-1.

Industrial premises can contain a variety of wireless communication technologies and other sources of radio emissions.

This document is intended for designers and persons responsible for production and process plants, system integrators and mechanical engineers having to integrate and start up wireless systems in machines and plants, and producers of industrial wireless solutions. In particular, it is intended to motivate exchange of information between automation and radio engineers.

Many wireless industrial automation applications are also located in physical environments over which the operator/owner can exert control. That is, within a physical facility where the presence and operation of all radio emitting devices are under the control of a single entity. This allows wireless management strategies to be employed which are not feasible for equipment installed in public or other unmanaged areas.

In industrial automation, many different wireless communication systems can operate in the same premises. Examples of these communication systems are IEC 62591 (WirelessHART^{®1}), IEC 62601 (WIA-PA) and IEC 62734 (ISA100.11a). All these communication systems use IEEE 802.15.4 [28]² for the process automation applications. Other examples of wireless communication systems are specified in IEC 61784-1 and IEC 61784-2 CPs that use IEEE 802.11 [25] and IEEE 802.15.1 [26] for factory automation applications. Different to wired fieldbuses, the wireless communication devices can interfere with others on the same premises or environment, disturbing each other. Other sources of radio energy in these bands, often at high energy levels, include radiated process heating, plastic welding, plasma lamps, and microwave irradiation devices.

Clearly, without a means to manage the coexistence of these varied emitters, it would be problematic to ensure that wireless systems meet the time-criticality and other performance requirements of industrial automation.

This document describes the management of independent radio sources that use the same transmission medium. The management within a wireless communication system is not the subject of this document. It is assumed that the standard of a wireless system regulates it, for example by a medium access control mechanism.

The IEC 62657 series has four parts:

- Part 1: Wireless communication requirements and spectrum considerations
- Part 2: Coexistence management
- Part 3: Formal description of the automated coexistence management and application guidance
- Part 4: Coexistence management with central coordination of wireless applications

IEC 62657-1 provides general requirements for industrial automation and spectrum considerations that are the basis for industrial communication solutions. This document specifies the coexistence management of wireless devices to ensure predictable performance. It is intended to facilitate harmonization of future adjustments to international, national, and local regulations.

This document provides the coexistence management concept and process. Based on the coexistence management process, a predictable assuredness of coexistence can be achieved for a given spectrum with certain application requirements. This document describes principles to manage the potential mutual interference that might occur due to the operation of multiple wireless devices in a plant.

This document provides guidance to the users of wireless systems on selection and proper use of wireless systems. To provide suitable wireless devices to the market, it also serves vendors in describing the behaviors of wireless devices to build wireless systems matching the application requirements.

This document is based on analyses of a number of International Standards, which focus on specific technologies. The intention of this document is not to invent new parameters but to use already defined ones and to be technology independent.

¹ WirelessHART is the registered trade name of the FieldComm Group, see www.fieldcommgroup.org. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

² Numbers in square brackets refer to the bibliography.

INDUSTRIAL NETWORKS – COEXISTENCE OF WIRELESS SYSTEMS –

Part 2: Coexistence management

1 Scope

This part of IEC 62657:

- specifies the fundamental assumptions, concepts, parameters, and procedures for wireless communication coexistence;
- specifies coexistence parameters and how they are used in an application requiring wireless coexistence;
- provides guidelines, requirements, and best practices for wireless communication's availability and performance in an industrial automation plant; it covers the life-cycle of wireless communication coexistence;
- helps the work of all persons involved with the relevant responsibilities to cope with the critical aspects at each phase of life-cycle of the wireless communication coexistence management in an industrial automation plant. Life-cycle aspects include: planning, design, installation, implementation, operation, maintenance, administration and training;
- provides a common point of reference for wireless communication coexistence for industrial automation sites as a homogeneous guideline to help the users assess and gauge their plant efforts;
- deals with the operational aspects of wireless communication coexistence regarding both the static human/tool-organization and the dynamic network self-organization.

This document provides a major contribution to national and regional regulations. It does not exempt devices from conforming to all requirements of national and regional regulations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62657-1:2017, *Industrial communication networks – Wireless communication networks – Wireless communication requirements and spectrum considerations*

IEC 62657-3, *Industrial networks – Coexistence of wireless systems – Part 3: Formal description of the automated coexistence management and application guidance*

IEC 62657-4, *Industrial networks – Coexistence of wireless systems – Part 4: Coexistence management with central coordination of wireless applications*

IEC 62443 (all parts), *Industrial communication networks – Network and system security*

3 Terms, definitions, abbreviated terms and conventions

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1.1

active environmental influence

influence on the signal propagation through interfering of the wireless communication application or wireless application

3.1.2

adjacent channel interference

interference that occurs from wireless devices using adjacent frequency channels

3.1.3

adjacent channel selectivity

ability of a radio receiver to respond to the desired signal and to reject signals in adjacent frequency channels

3.1.4

antenna gain

ratio of the power required at the input of a reference antenna to the power supplied to the input of the given antenna to produce, in a given direction, the same field strength at the same distance

[SOURCE: Federal Standard 1037C:1996, modified – Deletion of "loss-free" before "reference antenna", deletion of the two notes and synonyms] [29]

3.1.5

antenna radiation pattern

variation of the field intensity of an antenna as an angular function with respect to the axis

3.1.6

antenna type

kind of part of a radio transmitting or receiving system which is designed to provide the required coupling between a transmitter or a receiver and the medium in which the radio wave propagates

Note 1 to entry: In practice, the terminals of the antenna or the points to be considered as the interface between the antenna and the transmitter or receiver should be specified.

Note 2 to entry: If a transmitter or receiver is connected to its antenna by a feed line, the antenna may be considered to be a transducer between the guided waves of the feed line and the radiated waves in space.

[SOURCE: IEC 60050-712:1992, 712-01-01, modified – Addition of "kind of" at front]

3.1.7

application communication requirements

quantitative requirements specifying the required conditions and the required characteristics of wireless communication solutions at the communication interface that is met in order to achieve the purpose of the automation application

3.1.8**area of operation**

distinguishing properties of the area where the wireless communication system is operated

3.1.9**automated collaborative coexistence management**

tool supported collaborative coexistence management with defined interfaces between the tool and the wireless communication system

Note 1 to entry: The tool can be according to IEC 62657-4³.

3.1.10**automation application**

industrial automation application

application of measurement and automatic control in the industrial automation domain

3.1.11**automation application data length**

user data length

number of octets that are exchanged at the reference interface

3.1.12**bit rate of the physical link**

measure of the number of binary digits transferred per second

3.1.13**blocking frequency**

ability of a device to avoid part of the available spectrum

[SOURCE: ETSI TR 102 889-2: 2011, modified – Changed "blacklisting frequencies" to "blocking frequency"] [22]

3.1.14**blocked frequency list**

list of the blocked frequencies to avoid part of the available spectrum

[SOURCE: ETSI TR 102 889-2: 2011, modified – Exchanged "blacklisting frequencies" by "blocked frequency list" and added "to avoid part of the available spectrum"] [22]

3.1.15**cellular topology**

cellular network topology

network topology where the geographical area is divided in cells

Note 1 to entry: A device can move from one cell to another cell. Devices that are in a cell communicate through a central hub. Hubs in different cells are interconnected.

3.1.16**centre frequency**

geometric mean of lower cut-off frequency and upper cut-off frequency of a frequency channel

3.1.17**channel number**

unsigned integer number identifying a wireless communication channel in accordance with an authoritative document or rule

³ Under preparation. Stage at the time of publication: IEC FDIS 62657-4:2022.

3.1.18

channel occupation

time interval in which the medium is busy

Note 1 to entry: Beyond the pure transfer of user data, this time includes all time slices necessary to process the transmission protocol, for example to transfer an acknowledgement.

3.1.19

coexistence

wireless communication coexistence

state in which all wireless communication solutions of a plant using shared medium fulfil all their application communication requirements

Note 1 to entry: In IEEE 802.15.2-2003 [27] the coexistence is defined as a characteristic of a device.

3.1.20

coexistence management

process to establish and to maintain coexistence that includes technical and organizational measures

3.1.21

coexistence management information

parameters for the wireless coexistence management process

3.1.22

coexistence manager

role of a nominated person to manage coexistence

3.1.23

coexistence planning

process that describes the allocation of wireless communication resources (time, frequencies, coding, space) to each wireless communication system in order to achieve coexistence

3.1.24

collaborative coexistence management

coexistence management process in which data is exchanged between the wireless communication applications involved with the aim of influencing the wireless communication so that all applications meet the requirements

3.1.25

communication availability

<wireless communication> ratio of the time interval of error free transmission (uptime) to an observation time

3.1.26

communication availability

<performance> ability of an item to be in a state to perform as required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided

Note 1 to entry: This ability depends on the combined aspects of the reliability performance, the maintainability performance, and the maintenance support performance.

Note 2 to entry: Required external resources, other than maintenance resources, do not affect the availability performance of the item.

3.1.27

communication load

amount of user data to be transmitted from the automation application within a certain period of time

3.1.28**communication reliability**

ability of a physical link and the related nodes to perform communication services under given conditions for a given time interval

3.1.29**cut-off frequency**

frequency limit, nearest to the frequency where the spectral power density drops below a certain level, defining the frequency bandwidth

3.1.30**data throughput**

ratio between the number of user data transferred to the application at the target reference interface and the observation time

3.1.31**device**

piece of hardware that provides connectivity and functionality

Note 1 to entry: Does not exclude software using the hardware to perform functions or support connectivity

3.1.32**device type**

shared characteristics of a device as specified so that the used devices build instances of the shared characteristics

EXAMPLE The specification can be part of a catalogue from a manufacturer.

Note 1 to entry: These shared characteristics include: technology, design, area of application, parts or modules with respect to safety, EMC, performance, functionality, etc.

Note 2 to entry: The shared characteristics of a device type may be engineered, configured and parameterized in a device instance.

3.1.33**distance between wireless devices**

geographical distance between devices within a three-dimensional space

3.1.34**distributed automation system**

functions of the automation devices that are the spatial extent of a wireless industrial automation

3.1.35**duty cycle**

ratio of the transmitter sequence referenced to a given observation time for the used frequency channel

3.1.36**dwel time**

period spent at a particular frequency during any single hop of a frequency hopping system

3.1.37**equivalent isotropic radiated power**

product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain)

[SOURCE: ITU Radio Regulations, edition of 2020 – Art.1 §1.161, modified – Term modified from isotropically to isotropic and definition reformatted according to the ISO/IEC Directives Part 2] [31]

3.1.38

effective radiated power

product of the power supplied to the antenna and its gain relative to a half-wave dipole in a given direction

[SOURCE: ITU Radio Regulations, edition of 2020 – Art.1 §1.162, modified – Deleted “(in a given direction)” and definition reformatted according to the ISO/IEC Directives Part 2] [31]

3.1.39

electromagnetic interference

EMI

degradation of the performance of equipment or transmission channel or system caused by an electromagnetic disturbance

Note 1 to entry: In French, the terms "perturbation électromagnétique" and "brouillage électromagnétique" designate respectively the cause and the effect, and should not be used indiscriminately.

Note 2 to entry: In English, the terms "electromagnetic disturbance" and "electromagnetic interference" designate respectively the cause and the effect, and should not be used indiscriminately.

[SOURCE: IEC 60050-161:2018, 161-01-06]

3.1.40

frequency band

range in the frequency spectrum that is assigned by regulatory organizations for use for specific applications or a group of applications

Note 1 to entry: The ITU as international regulatory organization assigns only radio communication services to a specific range in the frequency spectrum.

3.1.41

frequency bandwidth

bandwidth

difference between upper cut-off frequency and lower cut-off frequency

3.1.42

frequency channel

span of the frequency spectrum which is characterized by lower cut-off frequency and upper cut-off frequency or by centre frequency and frequency bandwidth

3.1.43

frequency hopping sequence

sequence of frequency channels used for transmission (hopping sequence) and dwell time

3.1.44

future expansion plan

possible installation of new wireless communication solutions and buildings that can affect coexistence

3.1.45

general plant characteristics

parameters that characterize the plant in general with respect to all wireless communication applications

3.1.46

geographical dimension of the plant

length, width and height of the intended space of the wireless system

3.1.47**geolocation capability**

capability of equipment to determine its geographical location

3.1.48**industrial, scientific and medical application**

operation of equipment or appliances designed to generate and use locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunications

[SOURCE: ITU Radio Regulations, edition of 2020 – Art.1 §1.15] [31]

3.1.49**industrial communication network**

data communications sub-systems for industrial-process measurement and control as well as on instrumentation systems used for research, development or testing purposes

3.1.50**infrastructure device**

device that is essential for building up a wireless communication system according to a technology or standard, but not having an interface to an automation application

EXAMPLE Router or base stations without interfaces to the wired industrial network or without automation application functions.

3.1.51**initiation of data transmission**

method that specifies how the application initiates the data transfer

3.1.52**interference**

radio frequency interference

effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a wireless communication system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy

[SOURCE: ITU Radio Regulations, edition of 2020 – Art.1 §1.166, modified – Deleted leading "The" according to ISO/IEC Directives Part 2] [31]

3.1.53**interference type**

kind of unwanted energy caused by a certain source or application

Note 1 to entry: Examples of interference types are: an EMI source, an ISM application, or a non-industrial wireless application.

3.1.54**intermodulation sensitivity**

levels of out-of-band interfering signals that, when mixed in the receiver front-end, produce an in-band third order non-linearity product

3.1.55**intervisibility**

property of a logical link that describes a possible influence on radio signal propagation by obstruction, refraction or reflection

EXAMPLE Line of Sight (LOS), Non-Line of Sight (NLOS) and Obstructed Line of Sight (OLOS) between those devices are possible parameters.

3.1.56

immunity

ability of an item to continue operating properly in the event of an interference, up to a certain level of interference, and to be resilient above this level

Note 1 to entry: Immunity of an item is achieved by adding to the robustness of the item the ability to be resilient to interference.

3.1.57

jitter

time variation of an expected occurrence

Note 1 to entry: Examples are variation of transmission time and update time.

3.1.58

length of user data per transfer interval

number of the octets sent out during a transfer interval, where the octets that are added because of the requirements of the wireless communication protocol are subtracted

Note 1 to entry: The application data length affects the communication load and might account for the temporal separation of the wireless communication systems.

3.1.59

life-cycle

length of time from the start of the development phase of a product type to the product abandonment

[SOURCE: IEC 62890:2020, 3.1.22]

3.1.60

limitation from neighbours of the plant

description of the neighbors of the plant that are likely to cause limitations for wireless communication

EXAMPLE High power radio source(s).

3.1.61

linear topology

linear network topology

topology where the nodes are connected in series, with two nodes connected to only one other node and all others each connected to two other nodes (that is, connected in the shape of a line)

Note 1 to entry: This topology corresponds to that of an open ring.

[SOURCE: IEC 61918:2018, 3.1.51, modified – Added an admitted term]

3.1.62

line of sight

LOS

path of propagation of a radio frequency (RF) signal that is not obscured (partially or completely) by obstacles

3.1.63

lower cut-off frequency

frequency furthest below the frequency of maximum power where the power spectral density drops below a certain level

3.1.64**maximum number of retransmissions**

upper limit of how many times the communication stack is allowed to retransmit user data automatically because of transmission errors

3.1.65**mechanism for adaptivity**

measures to modify one or more of the systems operational parameters in order to improve the systems robustness against interferences and to minimize the medium utilization

3.1.66**medium access control mechanism**

transmission technique for how to access the medium

Note 1 to entry: Examples are CSMA, TDMA, or combination of both.

3.1.67**medium utilization factor**

measure to quantify the amount of resources (power and time) used by non-adaptive equipment

3.1.68**message**

ordered series of octets intended to convey information

Note 1 to entry: During the transport of the conveyed information, the octets can be split in various packets.

[SOURCE: ISO/IEC 2382-16:1996, 16.02.01, modified – Replaced "sequence of characters" by "series of octets", Note to entry added]

3.1.69**message loss ratio**

ratio of number of messages, transferred from the application at the reference interface within the producer, and the number of messages, transferred at the reference interface to the application within the consumer

3.1.70**mesh topology**

mesh network topology

network topology in which redundant physically-diverse routing paths are available between each pair of network nodes

Note 1 to entry: Wireless mesh topology is usable to extend coverage via multi-hop capability and/or to facilitate communication reliability by providing redundant paths between devices.

[SOURCE: IEC 62734:2014, 3.1.2.95, modified – Added an admitted term]

3.1.71**modulation**

process of varying one or more properties of a periodic waveform with a modulating signal that contains information to be transmitted

3.1.72**natural environmental condition**

condition that surrounds the wireless device and wireless system

Note 1 to entry: Examples are temperature, humidity, air pressure.

3.1.73

network

all of the media, connectors, repeaters, routers, gateways and associated node communication elements by which a given set of communicating devices are interconnected

[SOURCE: IEC 61158-2:2014, 3.1.30]

3.1.74

network topology

topology of a network

pattern of the relative positions and interconnections of the individual elements of the network

[SOURCE: IEC 61918:2018, 3.1.81, modified – Deleted the "Note 1 to entry" and added an admitted term]

3.1.75

node

addressable logical or physical device attached to the network

[SOURCE: IEC 62591:2016, 3.2.75]

3.1.76

non-line of sight

NLOS

path of propagation of a radio frequency (RF) signal that is obscured (partially or completely) by obstacles, thus making it difficult for the radio signal to pass through

Note 1 to entry: Common obstacles between radio transmitters and radio receivers are tall buildings, trees, physical landscape and high-voltage power conductors. While some obstacles absorb and others reflect the radio signal; they all limit the transmission ability of signals.

3.1.77

number of consecutive lost messages

counted value of not correct received messages between two successfully received messages

3.1.78

obstructed line of sight

OLOS

obstacles that intrude into the first Fresnel zone but do not block the LOS path, it is the constructive or destructive interference from the reflected wavefront that is of concern

Note 1 to entry: An intrusion into the inner most area of the first Fresnel zone will result in a decrease or fading of the received signal level. At the point where the obstruction becomes tangent to the LOS path, signal losses will be as much as 6 dB or more. Best practice is to maintain at least 60 % of the first Fresnel zone radius free of obstructions to avoid fading of the received signal.

3.1.79

operating time between failures

sum of the operating time periods between two successive failures on a logical link where the message is considered as a repairable item in the sense that a message can be repeated within the survival time

3.1.80

other frequency user

user which generates and uses radio energy without having the objective of telecommunication

Note 1 to entry: Examples are welding machine, electrical drive and frequency converter.

3.1.81**out-of-band emission**

emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions

[SOURCE: ITU Radio Regulations, edition of 2020 – Art.1 §1.144] [31]

3.1.82**object movement**

specification of the trajectory of mobile assets that can significantly influence the radio propagation conditions

Note 1 to entry: Examples for mobile objects are vehicles, cranes or persons.

3.1.83**observation time**

duration of the supervision of events

Note 1 to entry: Examples are the reception of user data or the use of a transmission medium by a wireless device. For them the observation time is the reference parameter to calculate the data rate and the duty cycle.

3.1.84**packet**

formatted, aggregated bits that are transmitted together in time across the physical medium

[SOURCE: IEC 62591:2016, 3.2.77]

3.1.85**passive environmental influence**

influence on the signal propagation through the characteristic of the area of operation, the dimension of the space of operation, the intervisibility, mobile objects and natural environmental conditions

3.1.86**performance requirements**

requirements describing the time and error behavior necessary to achieve the purpose of the automation application

3.1.87**physical link**

relation between radio transceivers (physical end points) of two wireless devices

3.1.88**plant**

managed facility, typically with a physically protected perimeter, hosting the physical process, operation, personnel, equipment

3.1.89**point-to-point topology**

point-to-point network topology

topology where two nodes are directly connected to each other

3.1.90**position of wireless device**

geographical position of the three-dimensional space in absolute or relative coordinates where the device is located

3.1.91

power spectral density

distribution as a function of frequency of the power per unit bandwidth of the spectral components of a signal or a noise having a continuous spectrum and a finite mean power

[SOURCE: IEC 60050-713:1998, 713-09-12]

3.1.92

purpose of the automation application

summary of the automation application supported by the wireless system to the extent needed to provide a useful overview of the requirements imposed on the wireless system

3.1.93

radio channel

model considers the characteristic of the frequency channel, the environmental conditions, the distance between the wireless devices, the antenna characteristic

3.1.94

radio environment

represents the transmission medium with passive environmental influences and active environmental influences

3.1.95

radio resource

means used by multiple wireless communication solutions for the purpose of radio signal transmission

3.1.96

radio robustness

attribute of wireless communication to fulfil the designated function despite the presence of other active wireless applications interfering in the sphere of influence

Note 1 to entry: This term has the same meaning as the definition of the term coexistence in IEEE 802.15.2:2003, 3.1.2 [27].

3.1.97

received signal strength indication

relative number for the field strength at the receiver of wireless devices, depending on the respective implementation of a radio technology

3.1.98

receiver blocking

effect of a strong interfering signal on the receiver's ability to detect a low-level wanted signal

3.1.99

receiver maximum input level

maximum signal power that the system can tolerate without distortion of the signal

3.1.100

receiver sensitivity

minimal signal power to receive data with a defined bit error ratio

3.1.101

reference interface

exposed interface between an automation application and the wireless communication function

Note 1 to entry: There is no consistently defined interface for measurement and automation. The interface of the device might be a serial or a parallel hardware interface, a fieldbus interface, a software interface, or serial, parallel, discrete, and analog interface.

3.1.102**regional radio regulation**

regulation of important coexistence parameters such as frequency band and output power related to the region where the wireless application is intended to be used

3.1.103**relative movement**

position of a wireless device over time

3.1.104**requirements influencing the characteristic of wireless solutions**

application communication requirements that influence the performance of wireless solutions and thus the coexistence state

3.1.105**response time**

time interval between the instant delivery of the first user data bit, or octet, of a message to the reference interface of a transmitter, and the instant when the last bit, or octet, of the confirmation message is delivered at the reference interface of the same transmitter, which can be assigned to the request

3.1.106**ring topology**

ring network topology

active network where each node is connected in series to two other nodes

[SOURCE: IEC 61918:2018, 3.1.71, modified – Changed "ring" by "ring topology" and added an admitted term]

3.1.107**robustness**

ability of an item to continue operating properly in the event of an interference, up to a certain level of the interference

Note 1 to entry: The robustness of an item may be increased with measures that modify one or more of its operational parameters.

3.1.108**security level**

requirement category for cyber security

3.1.109**spatial extent of the application**

cuboid defined by the positions and/or the maximum movement radius of the automation devices of a distributed automation system

3.1.110**shared medium**

resource of frequency band in particular area shared by several wireless applications

Note 1 to entry: In the industrial, scientific and medical (ISM)-bands, many wireless applications are used. Due to this joint use, the term shared medium is used in this document. The frequency bands are used by diverse ISM applications and wireless communication applications.

3.1.111**signal to interference and noise ratio**

quotient of the strength of the wanted signal and the strength of the unwanted signals, consisting of noise and interference

3.1.112

spatial coverage of the wireless communication system

spatial coverage specified by length, width and height of a cuboid that encloses the wireless communication system

3.1.113

spurious emission

emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information, including harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions

[SOURCE: ITU Radio Regulations, edition of 2020 – Art.1 §1.145] [31]

3.1.114

spurious response

receiver output due to unwanted signals

Note 1 to entry: That means having frequencies other than those of the tuned frequency channel.

3.1.115

star topology

star network topology

network of three or more devices topology where all devices are connected to a central device

[SOURCE: IEC 61918:2018, 3.1.77, modified – "topology" has been added, "point (which may be active or passive)" has been replaced by "device", and an admitted term has been added]

3.1.116

survival time

time that an application, consuming a communication service, continues without receiving an anticipated message

3.1.117

telecommunication

any transmission, emission or reception of signs, signals, writings, images and sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems

[SOURCE: ITU Radio Regulations, edition of 2020 – Art.1 §1.3] [31]

3.1.118

total radiated power

spatial power density integrated across the surface of the sphere

3.1.119

transfer interval

time difference between two consecutive transfers of user data from the automation application via the reference interface to the wireless communication function

3.1.120

transmission gap

gap between two successive channel usages by a transmitter

3.1.121

transmission output power

total radiated power reduced by losses between the transmitter output and the antenna

3.1.122**transmission time**

interval from starting the delivery of the first application data octet of a message to the reference communication interface of a producer until the delivery of the last application data octet of the same message from the reference communication interface of a consumer

3.1.123**transmitter sequence**

time that a transmitter uses a frequency channel without the possibility to be interrupted by a wireless device of the same system

3.1.124**transmitter spectral mask**

envelope of maximum values of power spectral density over a frequency range

3.1.125**tree topology**

tree network topology

network topology where all nodes are connected in a combination of a linear and a star topology

3.1.126**update time**

interval from the delivery of the last user data octet of the message of a producer, from the reference interface of a consumer to the automation application, until the delivery of the last user data byte of the following message of the same producer

3.1.127**upper cut-off frequency**

frequency furthest above the frequency of maximum power where the power spectral density drops below a certain level

3.1.128**wireless application**

any use of electromagnetic waves with devices or equipment for the generation and use of radio energy using radio environment with active and passive environmental influences

Note 1 to entry: The definition includes wireless communication systems with wireless communication functions representing a set of spatially distributed automation functions, distributed automation system with local functions and physical system with physical system functions.

Note 2 to entry: The definition includes radio determination equipment.

3.1.129**wireless communication**

communication in which electromagnetic radiations are used to transfer information without the use of wires or optical fibers

3.1.130**wireless communication application**

part of an industrial automation application that uses wireless communication

3.1.131**wireless communication solution**

parameters of wireless communication solutions which are implementations of wireless communication systems and devices

3.1.132**wireless communication solution density**

ratio of the number of wireless communication solutions and the spatial coverage of the plant

1034 **3.1.133**
 1035 **wireless communication system**
 1036 set of wireless communication devices, infrastructure devices and physical links communicating
 1037 using radio frequencies using various topologies

1038 **3.1.134**
 1039 **wireless device**
 1040 wireless automation device
 1041 equipment of wireless communication applications that uses radio waves for wireless
 1042 communication with other equipment of wireless communication applications

1043 **3.1.135**
 1044 **wireless device density**
 1045 number of wireless devices within the spatial coverage of the wireless communication system

1046 **3.1.136**
 1047 **wireless device receiver parameters**
 1048 specification of wireless receiver characteristics

1049 **3.1.137**
 1050 **wireless device solution**
 1051 parameters related to individual nodes within a system implementing a wireless communication
 1052 solution

1053 **3.1.138**
 1054 **wireless device transmitter parameters**
 1055 specification of wireless transmitter characteristics

1056 **3.1.139**
 1057 **wireless device type**
 1058 specification of a device according to the catalogue data

1059 **3.1.140**
 1060 **wireless network**
 1061 wireless communication network
 1062 network consisting of at least two wireless devices that established wireless communication

1063 **3.1.141**
 1064 **wireless network solution**
 1065 parameters related to a network as a whole used implementing a wireless communication
 1066 solution

1067 **3.1.142**
 1068 **wireless solution**
 1069 wireless communication solution
 1070 specific implementation or instance of a wireless communication system

1071 Note 1 to entry: A wireless solution may be composed of products of one or more producers.

1072 **3.1.143**
 1073 **wireless system**
 1074 wireless communication system
 1075 set of interrelated elements providing wireless communication

1076 Note 1 to entry: A wireless system is a high-level representation of a system, while a wireless solution is a practical
 1077 instance of a system.

1078 3.1.144**1079 wireless system type**

1080 parameters describing the kind of wireless communication system

1081 3.1.145**1082 wireless system type and wireless device type**

1083 parameters that characterize the model of a wireless system or a wireless device by providing
1084 the parameters to specify a wireless system type and a wireless device type

1085 3.1.146**1086 wireless technology or standard**

1087 naming the wireless technology or standard

1088 **EXAMPLE** Examples of standards specifying a wireless communication system are IEC 62591, IEC 62601 and
1089 IEC 62734.

1090 3.2 Abbreviated terms

1091 AFH Adaptive frequency hopping

1092 CEPT European conference of postal and telecommunications administrations

1093 CP Communication profile according to IEC 61784-2

1094 CSMA Carrier sense multiple access

1095 DAA Detect and avoid

1096 DAR Detect and reduce

1097 DAS Detect and suppress

1098 DECT Digital enhanced cordless telecommunications

1099 ECO European communications office (the electronic communications committee of
1100 CEPT)

1101 EIRP Equivalent isotropic radiated power

1102 EMC Electromagnetic compatibility

1103 EMI Electromagnetic interference

1104 ERP Effective radiated power

1105 GSM Global system for mobile communications

1106 IF Intermediate frequency

1107 IP Internet protocol

1108 ISM Industrial, scientific and medical

1109 IT Information technology

1110 ITU International telecommunication union

1111 LAN Local area network

1112 LOS Line of sight

1113 MAC Medium access control

1114 MLR Message loss ratio

1115 NLOS Non line of sight

1116 N/A Not applicable

1117 OLOS Obstructed line of sight

1118 PCB Printed circuit board

1119 PHY Physical layer

1120 PSD Power spectral density

1121 RF Radio frequency

1122	RFID	Radio frequency identification
1123	RSSI	Received signal strength indication
1124	SIR	Signal-to-interference ratio
1125	TDMA	Time division multiple access
1126	TRP	Total radiated power
1127	UMTS	Universal mobile telecommunications system
1128	WD	Wireless device
1129	WIA-PA	Wireless network for industrial automation – process automation
1130	WLAN	Wireless local area network
1131	ZVEI	Zentralverband Elektrotechnik- und Elektronikindustrie e.V.; the german electrical
1132		and electronic manufacturers' association

1133 3.3 Conventions

1134 NOTE The graphical representations of flow charts in figures are based on ISO 5807.

1135 The following conventions for the coexistence management parameter templates in Clause 8
1136 apply:

- 1137 • The column "Parameter" uses indentations to cluster certain parameters. The parameters
1138 that are more to the right belong to the parameter above that is more left.
- 1139 • The column "Usage" specifies whether the parameter is mandatory, optional, or selection,
1140 if one out of several parameters is selected.
- 1141 • The item "Value" can contain a range or a list of values if the parameters allow multiple
1142 options. If a parameter does not have a unit, then the item "Unit" shall be marked with not
1143 applicable (N/A).

1144 4 Coexistence concept in industrial automation

1145 4.1 Overview

1146 Wireless communication allows industrial processes to be implemented more cost-efficiently,
1147 flexibly and reliably, as well as allowing the use of new automation concepts. Industrial
1148 automation applications usually place stricter requirements on reliability and real-time capability
1149 of wireless communication than applications in the domestic and office domain. Industrial
1150 automation applications can also reside in industrial facilities with higher ambient
1151 electromagnetic interference (EMI) levels than those of in non-industrial domains.

1152 Additional sources of radio emissions will also need to be taken into account during coexistence
1153 management.

1154 NOTE In some industrial environments, other sources of radio emissions can be present within the same bands as
1155 used by the wireless communications systems. These emitters can include devices with unintentional emissions,
1156 such as high-power welding devices which generate wideband electromagnetic energy.

Because of those requirements, different wireless systems are used. It is quite likely that several wireless systems may operate simultaneously in one place. Since these wireless systems share a common medium, interferences can be assumed throughout their life-cycles. This impacts system performance including reliability and its ability to meet real-time response requirements. This document is intended to help identify potential risks and to recommend measures to control these risks, depending on the requirements of the industrial automation application. This document also illustrates that most often the coexistence of several wireless systems and simultaneously the efficient handling of the frequency spectrum as a limited resource is feasible if an appropriate approach is chosen, taking into account the respective requirements. In order to achieve this, a process is needed in which all aspects of the coexistence of wireless systems during design, commissioning, and operation, as well as maintenance, are considered. This process, called coexistence management of wireless solutions, is the subject of this document. Associated actions and decisions serve to comply with the claimed limit values for the application over the whole life-cycle of the plant.

This process can be more or less complex, depending on the relevance of the requirements related to the wireless communication for the plant. This complexity depends, among other aspects, on the characteristics of the wireless communication application served by each wireless solution (for example control with strict real time requirements), the number and location of the wireless solutions that can potentially interfere with each other, and the presence of any other radio emitters in the same bands.

If no, or just modest, requirements are made on the wireless system, a lower effort for the coexistence of wireless solutions will be necessary than in the case of a wireless system that is part of a control application with strict real-time requirements. However, it is strongly recommended to consider that additional wireless systems might be implemented later or that the requirements on the present wireless system might change in the future (for example due to additional applications). The plant design shall ensure that the applied coexistence measures match the requirements of the wireless system.

The state of coexistence is characterized by meeting the limit values of relevant parameters for all wireless communication applications in the considered area. This state of coexistence is accomplished with appropriate actions in planning and in operation. This clarifies that coexistence is not a static attribute of a wireless solution, but rather a state within the life-cycle of a plant. It is possible to leave this state temporarily or permanently due to certain events. The parameter limit values are determined by the automation application in which the wireless communication takes place. This also implies that the coexistence management shall be evaluated and established contextually and in full accordance with the automation application.

From a general point of view, coexistence of two or more wireless solutions can be achieved by making orthogonal the transmissions that come from different sources.

There are three possibilities to manage coexistence, where a) means a higher amount of labor hours to establish and maintain the coexistence management and b) and c) means an increasing level of automation:

- a) manual coexistence management (lowest level);
- b) automated non-collaborative coexistence management;
- c) automated collaborative coexistence management (highest level).

Automated techniques, and the algorithms on which they are based, are usually classified into two broad categories: collaborative and non-collaborative.

4.2 Objective

This document is focused on measures to provide coexistence of wireless systems for measurement and automation applications. These industrial automation applications can be classified in various ways. For example, in Table 1 they are classified according to the degree of the application criticality. Efforts for coexistence management can vary according to the classification described in Table 1.

Table 1 – Example of a classification of application communication requirements

Class	Application	Application communication requirements
Functional safety	Implementation of a safety-related system whose failure could have an impact on the safety of persons and/or the environment and/or the plant	The communication protocol should support functional safety communication and the coexistence management shall be established in order to fulfil all requirements of this document.
Control	Closed or open loop control	The communication protocol should support a higher availability, reliability, and time-criticality protocol than the one used for other application domains like consumer industry or telecommunication. The coexistence management shall be established in order to fulfil most of the requirements of this document.
Monitoring	Process visualization and alerting	No specific add-ons required for the communication protocol. Typically monitoring application can be satisfied by a relaxed set of requirements. The coexistence management shall be established in order to fulfil these minimum requirements.
NOTE The relative terms "most" and "minimum" are based on the graphical description in Figure 3.		

The classification of automation applications provided with Table 1 refers to the functional requirements of the process industry application to be satisfied. This classification can also be adapted in other application domains.

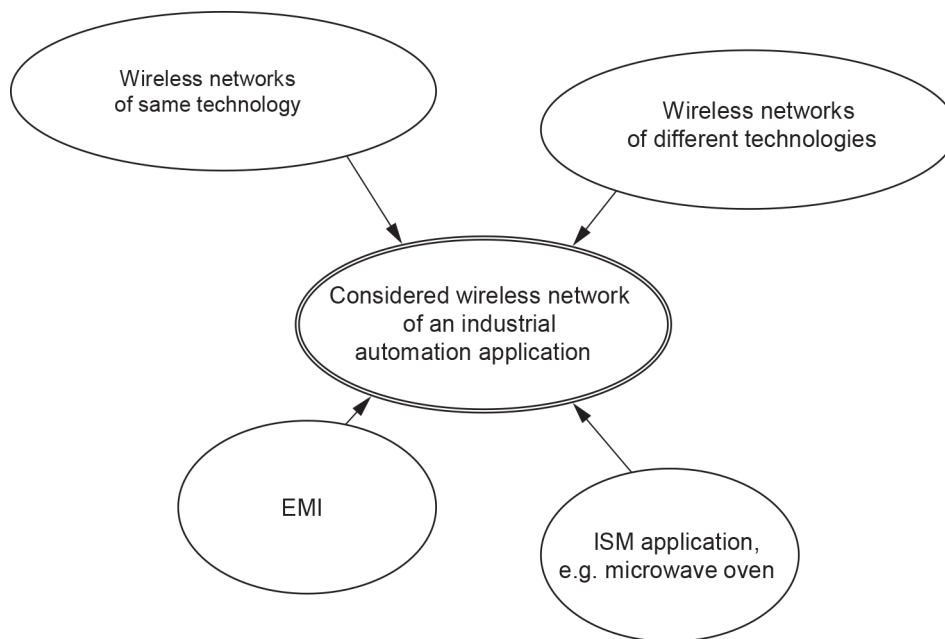
However, the determination of the criticality and the associated application communication requirements shall be determined on a case-by-case basis by the coexistence manager.

NOTE 1 Application communication requirements are described in IEC 62657-1.

Applications ranging from radio bar code readers to voice and video over IP applications can be classified likewise, and can be dealt with according to this document.

The applicability of this document is not confined to a specific frequency band, for example the 2,4 GHz ISM band. Both concurrent communication systems and other approved wireless applications, such as microwave systems for drying or plastics welding, are considered as interferences. Moreover, further interferences might occur due to powerful low frequency electromagnetic fields (for example transformers, powerful motors or other electromagnetic interferences (EMI), see Figure 1). The interference sources to be considered are detailed in 4.4.

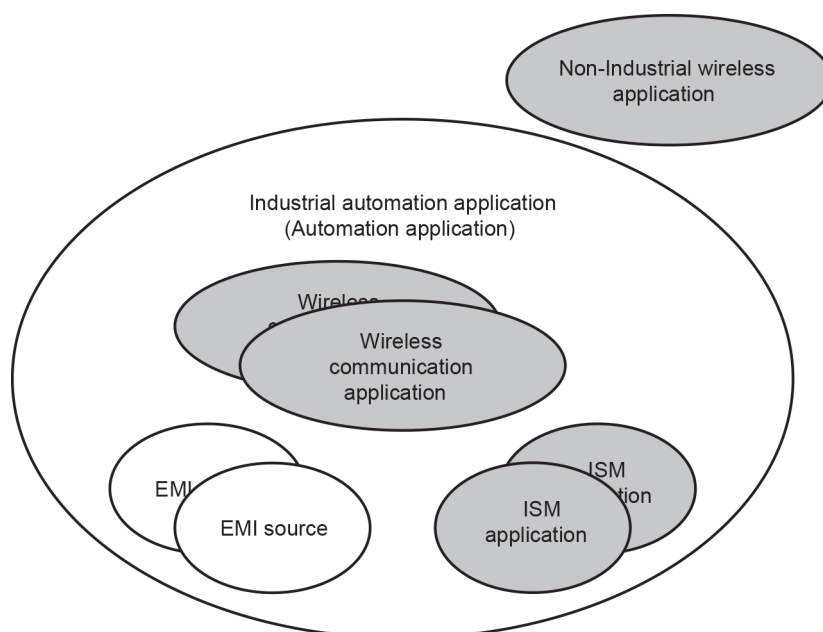
NOTE 2 The analysis of EMI is outside of scope of this document but has been considered.



IEC

Figure 1 – Issues of consideration

In Figure 2, the relation between industrial automation application, wireless communication application, EMI, industrial, scientific and medical (ISM) application and non-industrial wireless application is depicted. Wireless application is used as generic term for wireless communication application, ISM application and non-industrial wireless communication (grey in Figure 2). Wireless communication applications are parts of an automation application. Other parts of automation applications may use ISM spectrum e.g. for welding processes. Furthermore, equipment of industrial automation applications can be source of electromagnetic interference (EMI). In addition, non-industrial wireless applications (e.g. smart phones or laptops) may use the spectrum in an industrial environment.



IEC

Figure 2 – Applications using frequency spectrum

1239 This document is aimed at addressing coexistence management at the location of an enterprise;
1240 however, the manager shall take into consideration the fact that some interference could come
1241 from outside the location of the plant. The manager shall identify and characterize potential
1242 external radio energy sources and their distance from the enterprise. Controls should be in
1243 place to ensure that unauthorized or unaccounted mobile sources are not allowed in the
1244 enterprise area.

1245 It is assumed that, in conditions without interference, a wireless communication system
1246 basically meets the requirements of the wireless automation application and that, in particular,
1247 the limit values for time and error behavior are taken into account by planning the
1248 communication requirements.

1249 The measures described here are to ensure the required performance even in the presence of
1250 other wireless applications.

1251 **4.3 Necessity to implement a coexistence management**

1252 The frequency spectrum is a valuable limited resource which will be rapidly exhausted in the
1253 case of unmanaged use.

1254 The following list shows an example of wireless devices to be found in industrial environments:

- 1255 • wireless sensors and actuators;
- 1256 • WLAN access points and clients;
- 1257 • mobile panels;
- 1258 • RFID devices and RFID readers.

1259 There are also devices which can emit radiated power in the same bands as the wireless
1260 devices:

- 1261 • radio-frequency process heating;
- 1262 • plastic welding;
- 1263 • plasma lamps;
- 1264 • general welding; and
- 1265 • other devices.

1266 There is a high risk of interference whereby, under certain conditions, the assumed availability
1267 and performance requirements cannot be observed. In order to avoid this, or rather to reduce
1268 the risk of interference, a company-wide process for the administration of wireless applications
1269 for all parties involved is strongly recommended, and if adopted, shall be implemented
1270 according to this document. Coexistence management is an intra-company process which
1271 should be adjusted to the structure and the internal processes of the enterprise. In each
1272 individual company, the structure and the processes can be organized differently.

1273 Moreover, the focus in defining the process or its sub-steps can vary according to the user
1274 groups concerned:

- 1275 • wireless communication applications with a high data throughput, but relaxed real-time
1276 requirements: the coexistence management puts the focus on the provision of adequate
1277 frequency bandwidth;
- 1278 • wireless communication applications without specific requirements for performance and
1279 real-time: the coexistence management aims at ensuring the spatial coverage;
- 1280 • wireless communication applications with strict real-time requirements: the coexistence
1281 management safeguards against functional problems caused by the influence of other
1282 wireless applications (application classes Functional Safety or Control).

1283 In addition, the following basic measures to implement coexistence management are
1284 recommended:

- 1285 • nomination of a company-wide coexistence manager;
- 1286 • nomination of a location-specific coexistence manager if the company has several facilities;
- 1287 • establishment of a committee, consisting of contact persons of all company divisions using
1288 wireless applications (task of the committee should be the issues shown in Figure 1 and
1289 Figure 2);
- 1290 • inventory of all installed and, if possible, all planned wireless applications including wireless
1291 communication;
- 1292 • establishment of a policy to register new wireless applications or solutions and for the
1293 identification of existing ones;
- 1294 • coordination and adoption of decisions regarding the approval and application of wireless
1295 systems within the committee;
- 1296 • establishment of a policy and enforceable consequences for non-authorized introduction of
1297 new wireless applications or solutions.

1298 Effective coexistence management is a concerted process with representation of all company
1299 divisions concerned (sub-divisions, departments, technologies). The divisions concerned are
1300 those involved in planning, procurement, installation, commissioning, operation and
1301 maintenance of wireless applications, for example process planning, IT, automation, plant
1302 operation (production), development, purchasing, facility management.

1303 Coexistence management offers various benefits:

- 1304 • reduction or elimination of interferences leading to unplanned downtimes;
- 1305 • reduction or elimination of laborious, cost-intensive and time-consuming fault
1306 troubleshooting;
- 1307 • reduction or elimination of disinvestments in wireless solutions that cannot be operated in
1308 the present radio environment of the enterprise.

1309 NOTE The term 'wireless solution' is used here instead of the term 'wireless system' because it takes into account
1310 the distinct attributes of a product that are important for the coexistence management.

1311 **4.4 Interference potential**

1312 For wireless communication applications, interference will occur at a point in space
1313 (corresponding to an antenna location, received energy, antenna characteristics and
1314 polarization) if the received signals:

- 1315 • overlap in the frequency domain;
- 1316 • overlap in the time domain; and
- 1317 • overlap in coding.

1318 NOTE In the case of buildings and areas close to airports, harbors, transmitter masts and other places of powerful
1319 wireless systems, the interference potential is extremely high.

1320 This leads to interferences between wireless solutions so that, for example a transferred packet
1321 has to be repeated. The system reaction to the described interference depends on several
1322 factors, for example on the wireless standard, on the hardware and software implementation or
1323 on the application class (see Table 1) the wireless system uses for transfer.

1324 The separation of non-overlapping frequency channels is a method to achieve coexistence.
1325 However, there might be interference between wireless systems using different channels in the
1326 same frequency band, for example because of adjacent channel interference. This is called
1327 cross-channel interference. In particular, analog wireless systems hold a high interference
1328 potential for digital wireless systems due to their high channel occupation.