# IEC TS 62657-1

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# TECHNICAL SPECIFICATION

colour inside

## Industrial communication networks – Wireless communication networks – Part 1: Wireless communication requirements and spectrum considerations



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# INDUSTRIAL COMMUNICATION NETWORKS – WIRELESS COMMUNICATION NETWORKS –

## Part 1: Wireless communication requirements and spectrum considerations

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC/TS 62657-1, which is a technical specification, has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

The text of this technical specification is based on the following documents:

| Enquiry draft | Report on voting |
|---|---|
| 65C/741A/DTS | 65C/749/RVC |

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62657 series, published under the general title *Industrial communication networks – Wireless communication networks*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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# INTRODUCTION

The IEC 62657 series has two parts:

Part 1: Wireless communication requirements and spectrum considerations

Part 2: Coexistence management

This part of IEC 62657 provides general requirements of industrial automation and spectrum considerations that are the basis for industrial communication solutions. This Part 1 is intended to facilitate harmonization of future adjustments to international, national, regional and local regulations.

IEC 62657-2 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.

# INDUSTRIAL COMMUNICATION NETWORKS – WIRELESS COMMUNICATION NETWORKS –

## Part 1: Wireless communication requirements and spectrum considerations

## 1 Scope

This Technical Specification provides the wireless communication requirements dictated by the applications of wireless communication systems in industrial automation, and requirements of related context. The requirements are specified in a way that is independent of the wireless technology employed. The requirements are described in detail and in such a way as to be understood by a large audience, including readers who are not familiar with the industry applications.

Social aspects, environmental aspects, health aspects and market requirements for wireless communication systems in industrial automation are described to justify the wireless communication requirements.

This document also provides a rationale to successfully articulate the proposed short-term and long-term solutions. Coexistence management according to IEC 62657-2 is already applied in the short-term solutions.

This Technical Specification describes requirements of the industrial automation applications that can be used to ask for additional dedicated, worldwide unique spectrum. This additional spectrum is intended to be used for additional wireless applications while continuing using the current ISM bands.

This document provides useful information for the automation field professionals who are not familiar with the spectrum and wireless technologies.

Building automation is excluded from the scope because of the different usage constraints (for most non-industrial buildings it is normally difficult for the owner/operator to impose control over the presence and operation of radio equipment).

## 2 Normative references

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

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

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

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

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

IEC 62657-2:2013, *Industrial communication networks – Wireless communication network – Part 2: Coexistence management*

ETSI/TR 102 889-2:2011, *Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Short Range Devices (SRD); Part 2: Technical characteristics for SRD equipment for wireless industrial applications using technologies different from Ultra-Wide Band (UWB)*

## 3 Terms, definitions abbreviated terms and acronyms

### 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62657-2- and the following apply.

**3.1.1**
**automation application**
application of measurement and automatic control in the industrial automation domains

**3.1.2**
**availability (performance)**
ability of an item to be in a state to perform a 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.

[SOURCE: IEC 60050-191:1990, 191-02-05]

**3.1.3**
**coexistence**
**wireless communication coexistence**
state in which all wireless communication solutions of a plant using shared medium fulfill all their application communication requirements

Note 1 to entry: This is consistent with the definition of coexistence in IEEE 802.15.2-2003.

[SOURCE: IEC 62657-2:2013, 3.1.12]

**3.1.4**
**coexistence management**
process to establish and to maintain coexistence that includes technical and organizational measures

[SOURCE: IEC 62657-2:2013, 3.1.14]

**3.1.5**
**cognitive radio system**
radio system employing technology that allows the system to obtain knowledge of its operational and geographical environment, established policies and its internal state to dynamically and autonomously adjust its operational parameters and protocols according to its obtained knowledge in order to achieve predefined objectives; and to learn from the results obtained

[SOURCE: ITU-R SM.2152:2009] [10][1]

**3.1.6**
**conduit**
logical grouping of communication assets that protects the security of the channels it contains

Note 1 to entry: This is analogous to the way that a physical conduit protects cables from physical damage (see IEC 62443).

Note 2 to entry: A USB port is considered a conduit, but a USB device (e.g., memory stick) is considered an asset.

**3.1.7**
**Ethernet**
communication system according to ISO/IEC 8802-3 and IEEE 802.1D

**3.1.8**
**factory automation**
automation application in industrial automation branches typically with discrete characteristics of the application to be automated with specific requirements for determinism, low latency, reliability, redundancy, cyber security, and functional safety

Note 1 to entry: Low latency typically means below 10 ms delivery time.

**3.1.9**
**frequency band**
range in the frequency spectrum that is assigned by regulatory organizations for use for specific applications

[SOURCE: IEC 62657-2:2013, 3.1.21]

**3.1.10**
**plant**
complete set of technical equipment and facilities to accomplish a defined technical task

Note 1 to entry: A plant includes apparatus, machines, instruments, devices, means of transportation, control equipment and other operating equipment.

[SOURCE: IEC 60050-351:2006, 351-21-45]

**3.1.11**
**process automation**
automation application in industrial automation branches typically with continuous characteristics of the application to be automated with specific requirements for determinism, reliability, redundancy, cyber security, and functional safety

**3.1.12**
**reconfigurable radio system**
**RRS**
radio system encompassing software defined radio and/or cognitive radio system

**3.1.13**
**reliability**
ability of an item to perform a required function under given conditions for a given time interval

Note 1 to entry: It is generally assumed that the item is in a state to perform this required function at the beginning of the time interval.

[1] Numbers in square brackets refer to the Bibliography.

Note 2 to entry: The term “reliability” is also used as a measure of reliability performance (see IEC 60050-191:1990, 191-12-01).

[SOURCE: IEC 60050-191:1990, 191-02-06, modified – Note 2 to entry has been modified]

**3.1.14**
**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 and wireless applications.

[SOURCE: IEC 62657-2:2013, 3.1.38]

**3.1.15**
**software defined radio**
radio transmitter and/or receiver employing a technology that allows the RF operating parameters including, but not limited to, frequency range, modulation type, or output power to be set or altered by software, excluding changes to operating parameters which occur during the normal pre-installed and predetermined operation of a radio according to a system specification or standard

[SOURCE: ITU-R SM.2152:2009] [10]

**3.1.16**
**wireless application**
any use of electromagnetic waves with devices or equipment for the generation and use of radio frequency energy

[SOURCE: IEC 62657-2:2013, 3.1.46]

**3.1.17**
**wireless communication**
communication in which electromagnetic radiations are used to transfer information

**3.1.18**
**wireless communication solution**
specific implementation or instance of a wireless communication system

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

[SOURCE: IEC 62657-2:2013, 3.1.49]

**3.1.19**
**wireless communication system**
set of interrelated elements providing a wireless communication

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

[SOURCE: IEC 62657-2:2013, 3.1.50]

## 3.2 Abbreviated terms and acronyms

AGV Automated guided vehicle

AP Access point

APDU Application protocol data unit

BPCS Basic process control system

| | |
|---|---|
| CCS | Carbon dioxide capture and storage |
| $CO_2$ | Carbon dioxide |
| CP | Communication profile according to IEC 61784-1 or IEC 61784-2 |
| CR | Cognitive radio |
| CRC | Cyclic redundancy check |
| DAA | Detect and avoid |
| DCS | Distributed control system |
| DECT | Digital enhanced cordless telecommunications |
| DSL | Digital subscriber line |
| EC | European Commission |
| EDGE | Enhanced data GSM environment |
| EIRP | Equivalent isotropic radiated power |
| EM | Electromagnetic |
| EMC | Electromagnetic compatibility |
| EMI | Electromagnetic interference |
| EMS | Electromagnetic susceptibility |
| FSCP | Functional safety communication profiles |
| GPRS | General packet radio service |
| GPS | Global positioning system |
| GSM | Global system for mobile communications |
| I/O | Input/Output |
| ID | Identification |
| IEA | International energy agency |
| IP | Internet protocol |
| ISDN | Integrated services digital network |
| ISM | Industrial, Scientific and Medical |
| LAN | Local area network |
| LBT | Listen before talk |
| LOS | Line of sight |
| LTE | Long term evolution |
| MU | Medium utilization factor |
| NLOS | Non line of sight |
| OLOS | Obstructed line of sight |
| PC | Personal computer |
| PLC | Programmable logic controller |
| PPE | Personal protective equipment |
| RE | Renewable energies |
| RF | Radio frequency |
| RRS | Reconfigurable Radio System |
| SDR | Software defined radio |
| SIL | Safety integrity level |
| SIS | Safety instrumented system |
| SOP | Standard operating procedures |

| | |
|---|---|
| SRD | Short range devices |
| TDMA | Time Division Multiple Access |
| TS | Technical Specification |
| UMTS | Universal mobile telecommunications system |
| USB | Universal serial bus |
| WIA-PA | Wireless network for industrial automation – process automation |
| WLAN | Wireless local area network |
| WRT | Wireless real-time |

## 4 Wireless communication requirements of industrial automation – considerations for regulators

### 4.1 Worldwide harmonized frequency use

One of the reasons to enable worldwide use of wireless devices is that a wireless component will go through several steps of successive integration before being actually used (into a product, then a machine, then a factory), so the final geographical location of the wireless interface is not necessarily known. Regulation of the utilization of frequency bands is a matter of national sovereignty and has not yet been harmonized worldwide. Even when using the 2,4 GHz ISM band, national device approvals or licenses could be required. Furthermore, it could be necessary in some countries to gain approval for the operation of a wireless network, or to publish details of such a network in advance. Occasionally there are local usage restrictions related to the maximum transmission power that exceed international or regional norms, or a limitation of operation for indoor or outdoor areas. It is therefore important when exporting wireless systems to clarify in advance whether and under what circumstances the devices in question are permitted to be operated in the respective country.

NOTE Normally, manufacturers include such information in their documentation.

### 4.2 Coexistence management process (see IEC 62657-2)

Standard network solutions with specific performance characteristics (such as time criticality, safety and security) are used in industrial automation applications. The specific performance characteristics needed for industrial automation are identified and provided in Clause 5.

Examples of industrial domains are:

- process automation, covering for example the following industry branches:
  - Oil & Gas, refining,
  - chemical,
  - pharmaceutical,
  - mining,
  - Pulp & Paper,
  - Water & Wastewater,
  - steel;
- electric power, covering for example:
  - power generation (wind turbine, etc.),
  - power distribution (grid);
- factory automation, covering for example the following industry branches:
  - Food & Beverage,
  - automotive,
  - machinery,

– semiconductor.

In industrial automation nowadays there are both wired networks and wireless networks. Examples of these wireless networks are IEC 62591 (WirelessHART®2), IEC 62601 (WIA-PA) and IEC/PAS 62734 (ISA100.11a); all these networks use IEEE 802.15.4 for the process applications. Other examples of wireless networks are specified in IEC 61784-1 and IEC 61784-2 CPs that use IEEE 802.11 and IEEE 802.15.1 for factory automation applications. Unlike separately wired networks, wireless networks share the same media and thus may interfere with each other. Therefore, unless predicable coexistence is assured, operation of multiple wireless networks within the same facility could be problematic, resulting in the failure to meet time critical, safety and security requirements.

Typically, an industrial plant is in a fenced area and all the plant equipment are under the supervision of the plant management who can fully implement a coexistence management process for all the wireless networks of the plant.

In some cases the owner/operator may not be able to control, or may not choose to control, the equipment present. This document can also be used to assist in the identification of the resulting performance limitations.

The coexistence management process represents the activities of the coexistence management system. The coexistence management process includes technical and organizational activities in order to establish and to maintain the coexistence state of all wireless solutions in a plant. The coexistence parameters specified in IEC 62657-2:2013, Clause 5, and provided as described in IEC 62657-2:2013, Clause 6, are used in different phases of the coexistence management process. The coexistence management process consists of the following phases:

- investigation phase (see IEC 62657-2:2013, 7.4.1);
- planning phase (see IEC 62657-2:2013, 7.4.2);
- implementation phase (see IEC 62657-2:2013, 7.4.3);
- operation phase (see IEC 62657-2:2013, 7.4.4).

Robust wireless communication requires the use of a suitable coexistence management system. Such a system could use manual or automated procedures to ensure coexistence as discussed in IEC 62657-2.

Coexistence management should be established whatever spectrum is in use (licensed, unlicensed).

### 4.3 Concepts for using spectrum in wireless industrial applications

#### 4.3.1 General

This part of IEC 62657 discusses the following concepts and the resulting requirements for using spectrum in wireless industrial applications:

- coexistence management according to IEC 62657-2 in a controlled environment, see 4.2;
- use of suitable available spectrum for wireless industrial applications, see 4.3.2;
- dedicated spectrum for wireless industrial applications, see 4.3.3;
- additional concepts, see 4.3.4.

NOTE The order of the concepts does not mean any ranking or priority.

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