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Information technology — Radio frequency identification for item management —

Part 4: Parameters for air interface communications at 2,45 GHz

Technologies de l'information — Identification par radiofréquence (RFID) pour la gestion d'objets —

Partie 4: Paramètres de communications d'une interface d'air à 2,45 GHz

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, SC 31, *Automatic identification and data capture techniques*.

This third edition cancels and replaces the second edition (ISO/IEC 18000-4:2008), of which it constitutes a minor revision with the following changes:

— 5.1 has become Clause 5;

— 5.2 has become Clause 6;

— 5.3 has been Clause 7;

— Clause 8 has been introduced;

— Clause 6 has become Clause 9;

— Clause 1, Clause 2, Clause 3, Clause 4, Clause 5, and Clause 9 have been revised as necessary to also cover Clause 8.

ISO/IEC 18000 consists of the following parts, under the general title *Information technology — Radio frequency identification for item management*:

— *Part 1: Reference architecture and definition of parameters to be standardized*

— *Part 2: Parameters for air interface communications below 135 kHz*

— *Part 3: Parameters for air interface communications at 13,56 MHz*

— *Part 4: Parameters for air interface communications at 2,45 GHz*

— *Part 6: Parameters for air interface communications at 860 MHz to 960 MHz General*

— *Part 61: Parameters for air interface communications at 860 MHz to 960 MHz Type A*

— *Part 62: Parameters for air interface communications at 860 MHz to 960 MHz Type B*

— *Part 63: Parameters for air interface communications at 860 MHz to 960 MHz Type C*

— *Part 64: Parameters for air interface communications at 860 MHz to 960 MHz Type D*

— *Part 7: Parameters for active air interface communications at 433 MHz*

Introduction

This part of ISO/IEC 18000 is one of a series of International Standards and Technical Reports developed by ISO/IEC JTC 1/SC 31, WG 4 for the identification of items (item management) using radio frequency identification (RFID) technology.

This part of ISO/IEC 18000 defines three 2,45 GHz protocols. Each of the specific physical/data link configurations is defined in a separate sub-clause. The configuration descriptions include a physical layer and a data link layer.

The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) draw attention to the fact that it is claimed that compliance with this document can involve the use of patents concerning radio-frequency identification technology given in all parts of the document.

ISO and IEC take no position concerning the evidence, validity, and scope of these patent rights.

The holders of these patent rights have assured the ISO and IEC that they are willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statements of the holders of these patent rights are registered with ISO and IEC. Information can be obtained from the following companies.

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Information technology — Radio frequency identification for item management —

Part 4: Parameters for air interface communications at 2,45 GHz

1 Scope

This part of ISO/IEC 18000 defines the air interface for radio frequency identification (RFID) devices operating in the 2,45 GHz Industrial, Scientific, and Medical (ISM) band used in item management applications. This part of ISO/IEC 18000 provides a common technical specification for RFID devices that can be used by ISO committees developing RFID application standards. This part of ISO/IEC 18000 is intended to allow for compatibility and to encourage inter-operability of products for the growing RFID market in the international marketplace. This part of ISO/IEC 18000 defines the forward and return link parameters for technical attributes including, but not limited to, operating frequency, operating channel accuracy, occupied channel bandwidth, maximum equivalent isotropically radiated power (EIRP), spurious emissions, modulation, duty cycle, data coding, bit rate, bit rate accuracy, bit transmission order, and, where appropriate, operating channels, frequency hop rate, hop sequence, spreading sequence, and chip rate. This part of ISO/IEC 18000 further defines the communications protocol used in the air interface.

This part of ISO/IEC 18000 contains the following three modes:

— Mode 1 is an interrogator talks first with passive tag;

— Mode 2 is a tag talks first with battery-assisted passive tag;

— Mode 3 is a globally available, ubiquitous network supporting, among others, the logistics and transportation industry; agnostic to any device, commercial or otherwise, requiring global availability.

The detailed technical differences between the modes are shown in the parameter tables.

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.

ISO/IEC 7816-6:—[1)], *Identification cards — Integrated circuit cards — Part 6: Interindustry data elements for interchange*

ISO/IEC 15963, *Information technology — Radio frequency identification for item management — Unique identification for RF tags*

ISO/IEC/TR 18047-4, *Information technology — Radio frequency identification device conformance test methods — Part 4: Test methods for air interface communications at 2,45 GHz*

ISO/IEC 19762 (all parts):—[1)], *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

1) To be published

ISO/IEC/IEEE 8802-15-4:2010, *Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 15-4: Wireless medium access control (MAC) and physical layer (PHY) specifications for low-rate wireless personal area networks (WPANs)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762 (all parts):—[2] and the following apply.

3.1
associated
has successfully negotiated a di-directional wireless link with a coordinator

Note 1 to entry: Associated networks require communication be maintained and monitored for a period of time.

3.2
association
service used to establish membership for a device communicating within the wireless network described in this International Standard

3.3
block cipher
cryptographic function that operates on strings of fixed size

3.4
coordinator
full-function device (FFD) capable of relaying messages

Note 1 to entry: If a coordinator is the principal controller of a personal area network (PAN), it is called the PAN coordinator.

3.5
data server
device data termination point

3.6
device
any entity that meets the ISO/IEC/IEEE 8802-15-4 medium access control (MAC), physical interface to the wireless medium, and this protocol specification.

Note 1 to entry: A device can be a reduced-function device (RFD) or a full function device (FFD).

3.7
encryption
transformation of a message into a new representation so that privileged information is required to recover the original representation

3.8
full-function device
FFD
device capable of operating as a coordinator

3.9
group key
key that is known only to a set of devices

2) To be published.

3.10
hailing channel
ISO/IEC/IEEE 8802-15-4 radio channel used to broadcast the NDB

3.11
key
privileged information that can be used, for example, to protect information from disclosure to, and/or undetectable modification by, parties that do not have access to this privileged information

3.12
link key
secret key that is shared between precisely two devices

3.13
mesh networking
type of network where an FFD serves as a relay for other devices

3.14
message integrity code
MIC
data whereby an entity receiving a message corroborates evidence about the true source of the information in the message and, thereby, evidence that the message has not been modified in transit

3.15
network channel
primary ISO/IEC/IEEE 8802-15-4 radio channel between a coordinator and remote devices

3.16
packet
formatted, aggregated bits that are transmitted together in time across the physical medium

3.17
payload data
contents of a data message that is being transmitted

3.18
reduced-function device
RFD
device that is not capable of operating as a coordinator

3.19
server connected coordinator
SCC
network coordinator that terminates the wireless protocol described in this International Standard and is connected to control servers

3.20
tag
any device type associated with the device and capable of joining the network

4 Symbols and abbreviated terms

ACK	acknowledgement
CCITT	Comité Consultatif International Téléphonique et Télégraphique
Cht	Carrier high level tolerance
Clt	Carrier low level tolerance

CRC	cyclical redundancy check
CSMA	carrier sense multiple access
$f_{bitrate}$	base frequency of the bit rate of Manchester code without bit changes
f_c	frequency of operating field (carrier frequency)
FCF	frame control field
FCS	frame check sequence
FHSS	Frequency Hopping Spread Spectrum
M	Modulation
Ma	Modulation overshoot
MAC	medium access control
Mb	Modulation undershoot
MIC	message integrity code
MIN	Manufacturing Identification Number
Mlt	Modulation lower tolerance
Mut	Modulation upper tolerance
NAK	no-acknowledgement
NDB	Network Discovery Beacon
NSM	Network Status Message
QPSK	quad-phased shift keying
RTLS	real time locating system
Tbmf	Manchester fall time
Tbmr	Manchester rise time
Tcf	carrier fall time
Tcr	carrier rise time
Tcs	carrier steady time
TDMA	time division multiple access
Tf	fall time
Tfhf	carrier FHSS fall time
Tfhr	carrier FHSS rise time
Tfhs	carrier FHSS steady time
Tflb	forward link bit time
Tr	rise time

Trlb return link bit time

TTL tag talk last

5 General items on 2,45 GHz RFID protocols that support this part of ISO/IEC 18000

5.1 Protocols

Clause 5 describes the general items of the ISO/IEC 18000-4, 2,45 GHz RFID command/data level communication protocols. These protocols facilitate communication between compliant tag and compliant interrogator. The timing parameters and signal characteristics for the protocols are defined in the physical link specifications in each mode. Details of the Modes of various protocols are described in Clauses 6, 7 and 8.

5.2 Frequency

This part of ISO/IEC 18000 is intended to address RFID devices operating in the 2 450 MHz Industrial, Scientific and Medical (ISM) frequency band.

5.2.1 Interface definitions

This part of ISO/IEC 18000 supports standard parameters and standard air interface implementations for wireless, non-contact information system equipment for Item Management applications. Typical applications operate at ranges greater than one meter.

5.2.1.1 RFID system definition

The radio-frequency identification (RFID) system shall include a host system and RFID equipment (interrogator and tags). The host system runs an application program, which controls interfaces with the RFID. The RFID equipment shall be composed of two principal components: tags and interrogators. The tag is intended for attachment to an item, which a user wishes to manage. It is capable of storing a tag ID number and other data regarding the tag or item and of communicating this information to the interrogator. The interrogator is a device, which communicates to tags in its field of view. Additionally, the interrogator can use its transmitted RF carrier to power the tag. Systems, which rely on the transmitted interrogator carrier for powering the tag, are typically referred to as passive tag systems. The interrogator controls the protocol, reads information from the tag, directs the tag to store data in some cases, and ensures message delivery and validity.

5.2.1.2 Minimum features

RFID systems defined by this part of ISO/IEC 18000 provide the following minimum features:

— identify tag in range,

— read data,

— write data or handle read only systems gracefully,

— selection by group or address,

— graceful handling of multiple tags in the field of view,

— error detection.

5.2.1.3 Conformance

To claim conformance with this part of ISO/IEC 18000, an RFID system shall comply with one of the physical/data link implementations described in Clause 6, 7 and 8.

The rules for RFID device conformity evaluation are given in ISO/IEC 18047-4.

5.3 Tag identification number

A tag identification number shall be included in commands directed to a specific tag unless the protocol provides other means like TTF (Tag Talks First) protocols. This part of ISO/IEC 18000 mandates that each tag shall include a manufacturer's tag identification number as defined in Annex A for mode 1, in Annex C for mode 2 and in sub-clause 8.5.1 for mode 3.

A separate User Tag Identification is not mandatory, but is an option. When a UserTagID is used, it shall consist of the number of bytes required by the user application. This number and other application data shall be accessed as user data fields on the tag. These fields can be accessed via the API using the driver's field name resolution mechanism. The UserTagID is a user-defined tag identifier and is not necessarily unique.

5.4 Potential interference

Standards developers have a duty to ensure that no "significant interference" exists between Standardized modes. "Significant Interference" exists if a system of one Standardized mode (working within the most widespread regulated power emissions) is likely to impede the successful operation of a system of another Standardized mode (working within the most widespread regulated power emissions), *in likely expected operating situations.*

Marginal measurable interference that does not impede operation *in likely expected operating situations*, or that could be avoided by simple and inexpensive design improvement, shall not be considered cause to reject a mode.

— Therefore, TTF modes are clearly identified as such in this part of ISO/IEC 18000.

— Therefore, installers of RFID systems are advised that they should make best efforts to be a good neighbour in installing any systems, bearing in mind that there may be other systems sharing the same bandwidth and are advised to take precautions to minimise interference to other systems. Installers are equally advised to be prepared to handle interference within the bandwidth from other users up to transmission powers permitted by local regulations.

6 MODE 1: Passive backscatter RFID system

6.1 MODE 1: General

The FHSS backscatter option or the narrow band operation RFID system shall include an interrogator that runs the FHSS backscatter option 1 RFID protocol or in narrow band operation, as well as one or more tags within the interrogation zone.

When placed in the RF field of an interrogator, the tag shall begin to power up. If the field is adequate, the tag shall execute a power-on reset and shall be ready to receive commands. Each command shall begin with a preamble and start delimiters that, taken together, enable the tag to perform clock and data recovery on the incoming signal. Data to and from the tag is checked for errors using a Cyclic Redundancy Code (CRC). Therefore, CRC fields are present in all interrogator interrogations and in all tag responses. Additional data protection is provided by Manchester encoding on the forward (interrogator to tag link) and FM0 encoding on the return (tag to interrogator) link.

By using the FHSS backscatter option 1 RFID command set or in narrow band operation, the interrogator can execute a number of functions on tags in its field. For example, the interrogator can send a command sequence, which allows it to identify multiple tags simultaneously in its RF field. Alternately, it can select

a subset of the tags in the field based on tag memory contents. It can also read data stored on a tag in its field, as well as write or lock data to such a tag.

The description of the RFID tag command set in the following clause shall provide detail regarding the command field and return data/acknowledgement fields, if any. In addition, it shall cover additional high-level elements of the FHSS backscatter option RFID protocol, including how the multiple item identification algorithm works and byte ordering requirements. The more general aspects of the protocol (preambles, CRC-16, etc.) are covered in detail in 6.2.7.

This portion of the International Standard describes a passive backscatter RFID system that supports the following system capabilities:

System protocol

— Identify and communicate with multiple tags in the field

— Select a subgroup of tags to identify or communicate with based on information that the user has stored in the tag

— Read from and write or rewrite data many times to individual tags

— User controlled permanent lock memory

Data integrity protection

— Manchester bit-wise encoding and CRC-16 packet-level protection is applied to the forward link (interrogator-to-tag) data.

— FM0 bit-wise encoding and CRC-16 packet-level protection is applied to the return link (tag-to-interrogator) data.

In this RFID system, interrogators both power and communicate with the tags that are within their range. Tags receive data as on-off key amplitude modulation of the power/data signal from the interrogator. During the time that the tag communicates back to the interrogator, the interrogator broadcasts a steady radio frequency power level, and the tag modulates the impedance of its radio frequency load attached to the tag antenna terminals. The interrogator then receives the data back from the tag as a variation in reflection of its transmitted power.

6.2 Physical layer and data coding

6.2.1 Interrogator power-up waveform

The interrogator power-up waveform shall comply with the mask specified in Figure 1 and Table 1.