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# Information technology — Radio frequency identification for item management —

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

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

*Partie 7: Paramètres pour les communications actives d'une interface d'air à 433 MHz*

Reference number
ISO/IEC 18000-7:2004(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

ISO/IEC 18000-7 was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

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*

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

# Introduction

This part of ISO/IEC 18000 is intended to address RFID devices operating in the 433 MHz frequency band, providing an air interface implementation for wireless, non-contact information system equipment for Item Management applications. Typical applications operate at ranges greater than one meter.

The RFID system includes a host system and RFID equipment (interrogator and tags). The host system runs an application program, which controls interfaces with the RFID equipment. The RFID equipment is 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 RF communication range. 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. This system uses an active tag.

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

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 may involve the use of a patent concerning radio-frequency identification technology given in sub-clause 6.2.

ISO and IEC take no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the ISO and IEC that they are willing to negotiate licenses under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with ISO and IEC. Information may be obtained from the following companies.

<table>
<tr><th>Contact details</th><th>Patent holder</th><th>Patent title</th><th>Patent number</th><th>Affected subclause in this part of ISO/IEC 18000</th></tr>
<tr><td rowspan="3">Ravi Rajapaksi,<br>Chief Technology Officer,<br>Savi Technology, Inc.,<br>615 Tasman Dr.,<br>Sunnyvale,<br>CA 94089<br>USA</td><td>Savi Technology</td><td>Communication System for Communicating with Tags</td><td>US 5640151</td><td>6.2.6</td></tr>
<tr><td>Savi Technology</td><td>Communication System for Communicating with Tags</td><td>US 5686902</td><td>6.2.6</td></tr>
<tr><td>Savi Technology</td><td>Method and Apparatus for Radio Identification and Tracking</td><td>EP 0467036</td><td>6.2.6</td></tr>
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</table>

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. ISO or IEC shall not be held responsible for identifying any or all such patent rights.

# Information technology — Radio frequency identification for item management —

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

## 1 Scope

This part of ISO/IEC 18000 defines the air interface for radio frequency identification (RFID) devices operating as an active RF Tag in the 433 MHz band used in item management applications. The purpose of this part of ISO/IEC 18000 is to provide a common technical specification for RFID devices that may 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 power, 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.

## 2 Conformance

The rules for RFID device conformity evaluation will be given in a future Technical Report (ISO/IEC TR 18047-7).

## 3 Normative references

The following referenced documents are indispensable for the application 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.

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

ISO/IEC 19762-1, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 1: General terms relating to AIDC*[1)]

ISO/IEC 19762-3, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 3: Radio frequency identification (RFID)*[1)]

1) To be published.

# 4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762-1 and ISO/IEC 19762-3 apply.

# 5 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms given in ISO/IEC 19762-1 and ISO/IEC 19762-3 apply.

# 6 433,92 MHz active narrowband specification

## 6.1 Physical layer

The RF communication link between interrogator and tag utilizes narrow band UHF frequency with the following characteristics:

| | |
|---|---|
| Carrier Frequency | 433,92 MHz ± 20 ppm |
| Modulation Type | FSK |
| Frequency deviation | ± 50 kHz |
| Symbol LOW | fc +50 kHz |
| Symbol HIGH | fc –50 kHz |
| Modulation rate | 27,7 kHz |
| Wake up Signal | 30 kHz |

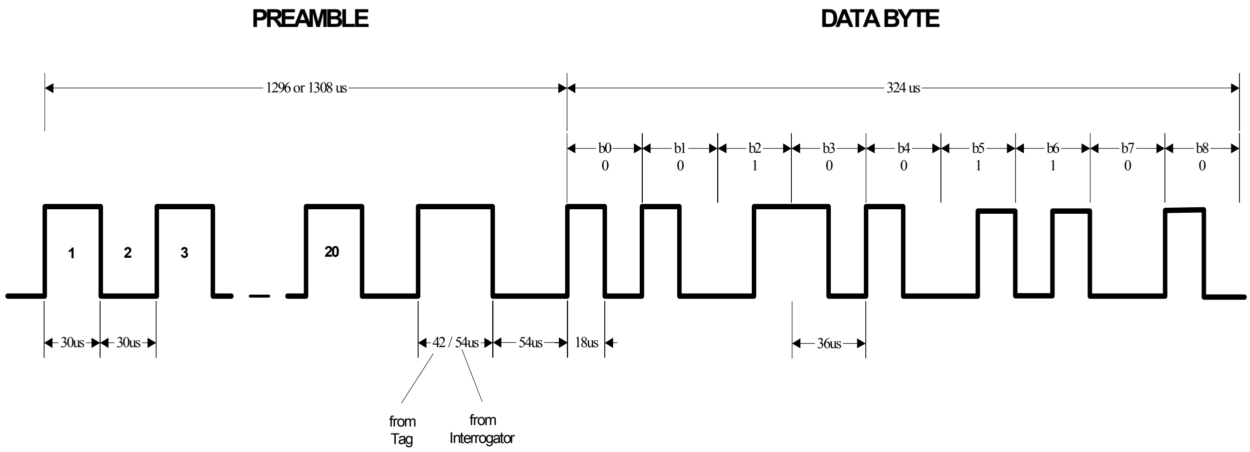
The Wake up signal is transmitted by interrogator for minimum of 2,5 seconds to wake up all tags within communication range. The wake up signal is a 30 kHz sub-carrier tone for 2,5 to 2,7 seconds. Upon detection of the Wake up signal all tags will enter into Ready state awaiting command from the interrogator.

The communication between interrogator and tag is of Master-Slave type, where the interrogator always initiates communications and then listens for response from a tag. Multiple response transmissions from the tags are controlled by collection algorithm described in section “Tag Collection and Collision Arbitration”.

## 6.2 Data Link layer

### 6.2.1 General

Data between interrogator and tag is transmitted in packet format. A packet is comprised of a preamble, data bytes and a final logic low period. The end of preamble and beginning of the first data byte is indicated by the last two pulses of the preamble. The same two pulses of the preamble also indicate the originator of the data packet. Data bytes are sent in Manchester code format. Transmission order is most significant byte first; within a byte, the order is least significant bit first. Figure 1 illustrates the data communication timing of the preamble and the first byte of a packet.




**Pulse width in microseconds. Data byte transmitted significant bit first. Byte shown is code 0x64.**

**Figure 1 — Data communication timing**

### 6.2.2 Preamble

The preamble is comprised of twenty pulses of 60 µs period, 30 µs high and 30 µs low, followed by a final sync pulse which identifies the communication direction: 42 µs high 54 µs low (Tag to Interrogator); 54 µs high 54 µs low (Interrogator to Tag).

### 6.2.3 Data byte format

Data bytes are in Manchester code format, comprised of 8 data bits and one stop bit. The bit period is 36 µs, the total byte period is 324 µs. A falling edge in the center of the bit-time indicates a 0 bit, a rising edge indicates a 1 bit. The stop bit is coded as a zero bit.

### 6.2.4 CRC bytes

A CRC checksum is calculated as a 16-bit value, initialized with all ones (‘FFFF’), over all data bytes (excluding preamble) according to the CCITT polynomial ($x^{16} + x^{12} + x^5 + 1$). The CRC is appended to the data as two bytes. Reference: “The CCITT Red Book”, Volume VIII, International Telecommunications Union, Geneva, 1986. Recommendation V.41, “Code-Independent Error Control System.”

### 6.2.5 Packet end period

A final period of 36 µs of continuous logic low is transmitted for each packet after the CRC bytes.

### 6.2.6 Interrogator to tag message format

Tags shall recognize the following message format:

**Table 1 — Interrogator to tag message format**

*Optional fields depending on the Command Type*      *Optional field depending on the Command Type*

MSB      LSB

| Command Prefix | Command Type | Owner ID | Tag ID | Interrogator ID | Command Code | Parameters | CRC |
|---|---|---|---|---|---|---|---|
| 1 byte<br>('31') | 1 byte<br>(8 bits) | 3 bytes | 4 bytes | 2 bytes | 1 byte | N bytes | 2 bytes |

The Owner ID, Tag ID and Parameters fields are present as required by the Command Type and Command code described in the following sections.

#### 6.2.6.1 Command type

**Table 2 — Command type field**

| Bit 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Reserved | Reserved | Reserved | Reserved | Reserved | 1 | 0= Broadcast<br>(Tag Id not present)<br>1= Point to Point<br>(Tag ID present) | 0= Owner ID not present<br>1= Owner ID present |

The Command Type field is used to indicate the presents of Tag ID and Owner ID fields within the current data packet. If Interrogator wishes to address a single tag by specifying its Tag ID, Bit 1 of the Command Type field needs to be set, indicating point-to-point communication. In the case Interrogator wants to address all the tags within its RF communication range, Bit 1 of the Command Type field needs to be cleared to indicate broadcast message. A broadcast message does not use Tag ID field and is omitted from the data packet.

The Bit 0 of the Command Type field indicates whether Owner ID is included in Interrogator to Tag message. If the Owner ID is included in the message all tags within Interrogator's RF communication range that belongs to the same Owner ID will respond back. All other tags shall ignore such message.

#### 6.2.6.2 Owner ID

The Owner ID field allows Interrogator to communicate with only those tags that belong to a specific owner ID group. The Owner ID can be arbitrarily programmed and subsequently changed within each tag's non-volatile memory. If the tag is not programmed with Owner ID or its value is set to zero tag shall respond to any Interrogator command that does not include Owner ID in the command message.

#### 6.2.6.3 Tag ID

The Tag ID is a 32-bit integer number that is uniquely assigned to each individual tag during manufacturing. This number cannot be changed and is read only. The Tag ID number has no structure and does not contain any information besides uniquely identifying a tag. The Tag ID cannot be reused. Issuance of the Tag IDs may be managed and administered by UCC/EAN, ISO 14816, ISO 6346, or some comparable international organization on behalf of the associated manufacture and is regulated by provision of agreement. ISO/IEC 15963 describes the structure of the Tag ID.

#### 6.2.6.4 Interrogator ID

The Interrogator ID is 16 bits integer number programmed into the Interrogator non-volatile memory. The Interrogator ID can be changed without any restrictions and is used to efficiently route tag responses through Interrogators network. The Interrogators that receive a tag message not addressed to them shall not pass the message to the system.

#### 6.2.6.5 Command codes

The Command codes and their function as a Read and / or Write command are summarized below. The least significant 7 bits of a command identify its base function, the eighth (MS) bit is set ‘0’ for a Read function and ‘1’ for a Write function. Codes not identified are reserved.

**Table 3 — Command codes**

| Command code (R / W) | Command name | Command type | Description |
|---|---|---|---|
| ‘10’ / NA | Collection | Broadcast | Collect all Tag IDs within interrogator RF communication range |
| ‘11’ / NA | Collection with Data | Broadcast | Collect all Tag IDs including specified data from tag’s non-volatile memory |
| ’14’ / NA | Collection with User ID | Broadcast | Collect all Tag IDs including tag’s User ID |
| NA / ’15’ | Sleep | Point to Point | Put Tag to sleep |
| ’01’ / NA | Status | Point to Point | Retrieve Tag status |
| ’07’ / ’87’ | User ID length | Point to Point | Sets length of the User ID (in bytes, 1 – 16) |
| ’13’ / ’93’ | User ID | Point to Point | Sets User assigned ID (1 – 16 bytes) |
| ’09’ / ’89’ | Owner ID | Point to Point | Set Owner ID (3 bytes) |
| ’0C’ / NA | Firmware revision | Point to Point | Set by manufacturer |
| ’0E’ / NA | Model Number | Point to Point | Set by manufacturer |
| ’60’ / ’E0’ | Read/Write Memory | Point to Point | Memory data |
| NA / ’95’ | Set Password | Point to Point | Sets Tag Password (4 bytes long) |
| ’17’ / ’97’ | Set Password Protect | Point to Point | Sets and Clears Tag Secure bit which enables or disables password protected access to the tag |
| NA/’96’ | Unlock | Point to Point | Unlocks password protected tag |

The Command Type column indicates whether the command is broadcast (does not include Tag ID in the message) or point-to-point (includes Tag ID in the message).

### 6.2.7 Tag to interrogator message format

The Tag to Interrogator message has two different formats depending on the type of message being transmitted to the Interrogator.

There are two possible formats:

- Broadcast response message format
- Point-to-Point response message format

#### 6.2.7.1 Broadcast response message format

This message format is used in response to all Interrogator broadcast commands, received by Interrogator within its communication range.

The broadcast commands are used to collect Tag Ids, User IDs or short blocks of data from the selected group of tags (all tags, particular tag type, etc.) using batch collection algorithm. See Collection Command section for more details.

The User ID field is optional and its use is controlled by the *Command Type* field bit ‘0’ as specified in *Interrogator to Tag message format*.

**Table 4 — Broadcast response message format**

| Tag Status | Message Length | Int ID | Tag ID | Owner ID | User ID | Data | CRC |
|---|---|---|---|---|---|---|---|
| 2 bytes | 1 byte | 2 bytes | 4 bytes | 3 bytes | 0-16 bytes | 0 – N bytes | 2 bytes |

**Tag Status**: Indicates various conditions such as response format, tag type, alert flag. See clause 6.2.5.2.3, **Tag Status,** for more details.

**Msg. Length**: Message length in bytes including CRC byte codes

**Int ID**: ID of Interrogator. Integer value from 1 to 65535

**Tag ID**: Unique Tag ID preset during manufacturing

**Owner ID**: Unique ID assigned to corporation.

**User ID**: User ID is optional field set by the user

**Data**: Data field depends on the type of collection command being used to collect the tags. This data field can include User ID or specific data block from tag’s memory.

**CRC**: CCITT code check bytes

#### 6.2.7.2 Point-to-point response message format

This message format is returned to the Interrogator as a response to all point-to-point commands, which require Tag ID in order to access particular tag (these include all commands except Collection commands).

**Table 5 — Point-to-point response message format**

| Tag Status | Message Length | Int ID | Tag ID | Command Code | Parameters | CRC |
|---|---|---|---|---|---|---|
| 2 bytes | 1 byte | 2 bytes | 4 bytes | 1 byte | N bytes | 2 bytes |

**Tag Status**: Indicates various conditions such as response format, tag type, alert flag. See clause 6.2.5.2.3, **Tag Status,** for more details.

**Msg. Length**: Message length in bytes including CRC byte codes

**Int ID**: ID of Interrogator, Integer value from 1 to 65535

**Tag ID**: Unique Tag ID preset during manufacturing

**Command Code**: This field contains received Command code

**Parameters**: This field contains parameters defined by Command code

**CRC**: CCITT code check bytes

#### 6.2.7.3 Tag status

The Tag Status field, which is included in all Tag to Interrogator messages, consists of the following information:

**Table 6 — Tag status field format**

| Bit | | | | | | | |
|---|---|---|---|---|---|---|---|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
| Mode field | | | | Reserved | Reserved | Reserved | Ack<br>1 = NAK<br>0 = ACK |

| Bit | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | Tag type | | | | User ID<br>1 = Used<br>0 = Not Used | Battery<br>1 = low<br>0 = good |

NOTE Reserved fields are set to a value of "0"

**Mode** field indicates response data format from the tag (Broadcast command, Point-to-Point command)

**Table 7 — Tag status field format**

| Mode field | Mode format code (bit15 – 12) |
|---|---|
| Broadcast Command | 0000 |
| Point to Point Command | 0010 |

**Acknowledgment** bit when set to '0' indicates a valid command (CRC ok and all fields valid) has been received from the Interrogator.

**Tag type** indicates tag capabilities or special features (memory size, sensor input, etc.). The code for Tags conforming to this part of ISO/IEC 18000 is '010'. All other codes are reserved.

**User ID** when set indicates that User ID is being included in the Collection response messages. If used only Tag ID is included in the Tag to Interrogator message.

**Battery status** bit when set indicates that ~80 % of the tag battery life is being reached.

#### 6.2.7.4 Command codes

##### 6.2.7.4.1 Collection

**Table 8 — Collection command format**

| Command Code | Windows size | Reserved |
|---|---|---|
| ‘10’ | 2 bytes | 1 bytes |

See clause 6.2.6 for further information on “window size.”

Collection operation is used to interrogate and collect all tags. Reserved byte is always set to ‘00’.

##### 6.2.7.4.2 Collection with data

**Table 9 — Collection with data command format**

| Command Code | Windows size | Start Address (M) | Number of Data bytes (N) |
|---|---|---|---|
| ‘11’ | 2 bytes | 3 bytes | 1 byte |

Where:

- **N** is integer number from 1 to 32
- **M** is address from 0 to maximum available tag memory

The Collection with Data operation is used to collect all tags and the contents of the their memory block specified through Start Address and Number of Data bytes parameters.

##### 6.2.7.4.3 Collection with user ID

**Table 10 — Collection with user ID command format**

| Command Code | Windows size |
|---|---|
| ‘14’ | 2 bytes |

The Collection with User ID command is used to collect all tags with their User ID.

##### 6.2.7.4.4 Sleep

Write

**Table 11 — Sleep command format (Write)**

| Command code |
|---|
| ‘15’ |

The Sleep command directs a specific Tag to enter the Sleep mode. The Tag will not respond to this command nor to any subsequent command until the Tag is awaken again by Wake Up signal.

#### 6.2.7.4.5 Read tag status

Read

**Table 12 — Read tag status command format (read)**

| Command code |
|---|
| ‘01’ |

Read Response. Status byte is defined in 6.2.5.2.3.

**Table 13 — Read tag status command format (read response)**

| Command code | Status |
|---|---|
| ‘01’ | 1 byte |

#### 6.2.7.4.6 Security — Set password

Write

**Table 14 — Set password command format (write)**

| Command code | Password |
|---|---|
| ‘95’ | 4 bytes |

Write Response

**Table 15 — Set password command format (write response)**

| Command code |
|---|
| ‘95’ |

This command sets the tag’s password. This command requires tag first to be unlocked before it can be accessed.

Initial value of the tag’s password is to ‘FFFFFFFF’.

#### 6.2.7.4.7 Security — Set password protect

Write

**Table 16 — Set password protect command format (write)**

| Command code | Secure |
|---|---|
| ‘97’ | 1 byte |

- If Secure byte is set to ‘01’, tag becomes password protected
- If Secure byte is set to ‘00’, tag password protection condition is cleared

Write Response

**Table 17 — Set password protect command format (write response)**

| Command code |
|---|
| ‘97’ |

This command sets or clears secure bit inside the tag. To clear (set to zero) secure bit, tag has to be first unlocked with proper password. If secure bit is set to ‘01’, access to all point to point commands are password protected. Broadcast commands are not affected by the status of secure bit.

Initially secure bit is set to zero.

#### 6.2.7.4.8 Security — Unlock

Write

**Table 18 — Unlock command format (write)**

| Command code | Password |
|---|---|
| ‘96’ | 4 bytes |

Write Response

**Table 19 — Unlock command format (write response)**

| Command code |
|---|
| ‘96’ |

This command “unlocks” the access to the tag. If password ID matches tag’s password tag shall respond to consecutive commands received from interrogator. If the password does not match, the tag shall not respond any point-to-point command. Tag shall remain in unlock state until it receives Sleep command or 30 seconds expires after unlock command was received.

#### 6.2.7.4.9 Privacy — User ID length

Read

**Table 20 — Privacy user ID length command format (read)**

| Command code |
|---|
| ‘07’ |

Read Response

**Table 21 — Privacy user ID length command format (read response)**

| Command code | User ID Length |
|---|---|
| ‘07’ | 8 bits |

Write

**Table 22 — Privacy user ID length command format (write)**

| Command code | User ID Length |
|---|---|
| ‘87’ | 8 bits |

Write response

**Table 23 — Privacy user ID length command format (write response)**

| Command code |
|---|
| ‘87’ |

The User ID length determines the length of User ID.

#### 6.2.7.4.10 Privacy — User ID

Read

**Table 24 — User ID command format (read)**

| Command code |
|---|
| ‘13’ |

Read Response

**Table 25 — User ID command format (read response)**

| Command code | User ID |
|---|---|
| ‘13’ | 0 – 16 bytes |

Write

**Table 26 — User ID command format (write)**

| Command code | User ID |
|---|---|
| ‘93’ | 1 – 16 bytes |

Write response

**Table 27 — User ID command format (write response)**

| Command code |
|---|
| ‘93’ |

The User ID has variable length (in 8 bit increments) and allows user to program its own user assigned asset ID. The length is defined through User ID Length field. User ID can be changed at any time and its interpretation is user specific.

#### 6.2.7.4.11 Privacy — Owner ID

Read

**Table 28 — Owner ID command format (read)**

| Command code |
|---|
| ‘09’ |

Read Response

**Table 29 — Owner ID command format (read response)**

| Command code | Owner ID |
|---|---|
| ‘09’ | 3 bytes |

Write

**Table 30 — Owner ID command format (write)**

| Command code | Owner ID |
|---|---|
| ‘89’ | 3 bytes |

Write Response

**Table 31 — Owner ID command format (write response)**

| Command code |
|---|
| ‘89’ |

Owner ID provides additional layer of privacy defined by the owner of the Tag. If the Owner ID field is present in the Interrogator’s command and the included ID does not match the Tag’s Owner ID, the Tag will not respond to the command. If the tag’s Owner ID is set to zero tag shall respond to any Owner ID specified by Interrogator.

### 6.2.7.5 Tag model and version

Following two commands are not mandatory for compliance with this part of ISO/IEC 18000.

#### 6.2.7.5.1 Firmware version

Read

**Table 32 — Firmware version command format (read)**

| Command code |
|---|
| ‘0C’ |

Read Response

**Table 33 — Firmware version command format (read response)**

| Command code | Firmware version |
|---|---|
| ‘0C’ | 1 bytes |

The Firmware Version indicates tag firmware version

#### 6.2.7.5.2 Model number

Read

**Table 34 — Model number command format (read)**

| Command code |
|---|
| ‘0E’ |

Read Response

**Table 35 — Model number command format (read response)**

| Command code | Model number |
|---|---|
| ‘0E’ | 2 bytes |

The Model Number indicates tag model number.

### 6.2.7.6 Read and write memory

#### 6.2.7.6.1 Write memory

Write

**Table 36 — Write memory command format (write)**

| Command Code | Number of bytes (N) | Start Address (M) | Data |
|---|---|---|---|
| ‘0E’ | 1 byte | 3 bytes | N bytes |

Response

**Table 37 — Write memory command format (write response)**

| Command Code |
|---|
| ‘0E’ |

Where:

— **N** is integer number from 1 to 46

— **M** is address from 0 to maximum available tag memory

#### 6.2.7.6.2 Read memory

Read

**Table 38 — Read memory command format (read)**

| Command Code | Number of bytes (N) | Start Address (M) |
|---|---|---|
| ‘60’ | 1 byte | 3 bytes |

Response

**Table 39 — Read memory command format (read response)**

| Command Code | Number of bytes (N) | Data |
|---|---|---|
| '60' | 1 byte | N bytes |

Where:

- **N** is integer number from 1 to 46
- **M** is address from 0 to maximum available tag memory

### 6.2.8 Tag collection and collision arbitration

The purpose of the collision arbitration sequence during tag collection is to perform an efficient and orderly collection of the tags placed within the interrogator communication range and to receive information on the tag capabilities and data contents in a single sequence. The information that the tag returns is specified by flags set in the command from the interrogator.

The interrogator is the master of the communication with one or multiple tags.

General explanation

The collision arbitration uses a mechanism, which allocates tag transmissions into slots within specified collection round (or so called window size). The minimum windows size is set to be 57,3 ms. A collection round consists of a number of slots. Each slot is long enough for the interrogator to receive a tag response. The actual duration of a slot is determined by the interrogator collection command type and is a function of the tag transmission time.

When the tags placed within the interrogator RF communication range receive "wake-up" signal that is broadcast by the interrogator, they will move into the Ready state.

The interrogator initiates a tag collection process by sending a Collection command. Tags receiving a Collection command randomly select a slot in which to respond, but the tags do not immediately start transmitting. The number of slots in a current collection round is determined by the interrogator command type. Each Collection command requires specific type and amount of data to be transmitted by the tag within single slot time. The initial window size is fixed and set to 57,3 ms. During the subsequent collision arbitration process, the interrogator dynamically chooses an optimum window size for the next collection round based on the number of collisions in the round. The number of collisions is a function of the number of tags present within the interrogator communication range that participate in the current collection round.

On receiving a Collection command, tags select a slot in which to respond. The selection is determined by a pseudo-random number generator. When a tag selects a slot_number it will wait for a pseudo-random time delay equal to a time of slot_number multiplied by slot_delay before it responds. The number of slots is determined by the current window size, indicated through the interrogator collection command type and a tag transmission time.

After the interrogator has sent the Collection command there are three possible outcomes:

a) The interrogator does not receive a response because either no tag has selected current slot or interrogator did not detect a tag response. The interrogator then terminates current collection round.

b) The interrogator detects a collision between two or more tag responses. Collisions may be detected either as contention from the multiple transmissions or by detecting an invalid CRC. The interrogator records collision and continue “listening” for a new tag in the subsequent slot.

c) The interrogator receives a tag response without error, i.e. with a valid CRC. The interrogator records the tag data and continues to listen for a new tag in the subsequent slot.

The collection round continues until all slots within the round have been explored.

When the Collection round is completed the interrogator starts transmitting Sleep command to all tags collected during the previous Collection round. The tags that receive Sleep command move to “sleep” mode and will not participate in collection in the subsequent collection rounds.

The interrogator immediately starts the next collection round by transmitting the Collection command.

This process continues until no more tags are being detected during three subsequent collection rounds.

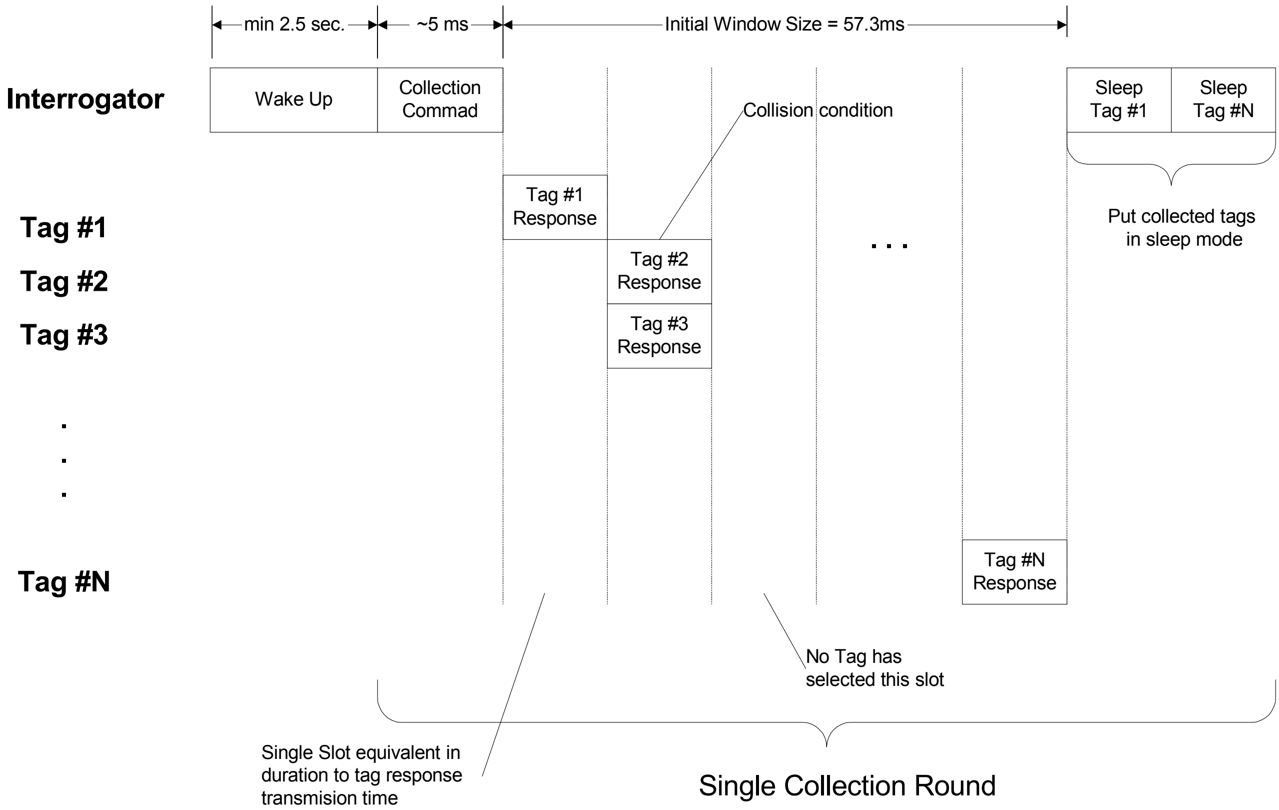



**Figure 2 — Collection sequence and timing**

## 6.3 Physical and Media Access Control (MAC) parameters

### 6.3.1 Interrogator to tag link

**Table 40 — Interrogator to tag link parameters**

| Ref. | Parameter | Value |
|---|---|---|
| Int:1 | Operating Frequency range | 433,92 MHz |
| Int:1a | Default Operating Frequency | 433,92 MHz |
| Int:1b | Operating Channels | Not applicable in this mode |
| Int:1c | Operating Frequency Accuracy | +/-20 ppm |
| Int:1d | Frequency Hop Rate | Not applicable in this mode |
| Int:1e | Frequency Hop Sequence | Not applicable in this mode |
| Int:2 | Occupied Channel Bandwidth | 500 kHz |
| Int:2a | Minimum Receiver Bandwidth | 500 kHz |
| Int:3 | Interrogator Transmit Maximum EIRP | 5,6 dBm (peak power) or as allowed by local regulations |
| Int:4 | Interrogator Transmit Spurious Emissions | |
| Int:4a | Interrogator Transmit Spurious Emissions, In-Band | Not applicable in this mode |
| Int:4b | Interrogator Transmit Spurious Emissions, Out of Band | The interrogator shall transmit in conformance with spurious emissions requirements defined by the country's regulatory authority within which the system is operated. |
| Int:5 | Interrogator Transmitter Spectrum Mask | Not applicable in this mode |
| Int:6 | Timing | |
| Int:6a | Transmit to Receive Turn Around Time | 50 microseconds |
| Int:6b | Receive to Transmit Turn Around Time | 50 microseconds |
| Int:6c | Interrogator Transmit Power On Ramp | 1 ms |
| Int:6d | Interrogator Transmit Power Down Ramp | 1 ms |
| Int:7 | Modulation | Frequency Shift Keying (FSK) |
| Int:7a | Spreading Sequence | Not applicable in this mode |
| Int:7b | Chip Rate | Not applicable in this mode |
| Int:7c | Chip Rate Accuracy | Not applicable in this mode |
| Int:7d | Modulation Index | Not applicable in this mode |
| Int:7e | Duty Cycle | Not applicable in this mode |
| Int:7f | FM Modulation | ± 35 kHz |
| Int:8 | Data Coding | Manchester, 36 µs bit period. Logic one: 18 µs low followed by 18 µs high, logic zero: 18 µs high followed by 18 µs low |
| Int:9 | Bit Rate | 27,7 kbit/s |
| Int:9a | Bit Rate Accuracy | 200 ppm |
| Int:10 | Interrogator Transmit Modulation Accuracy | Not applicable in this mode |

**Table 40** *(continued)*

| Ref. | Parameter | Value |
|---|---|---|
| Int:11 | Preamble | |
| Int:11a | Preamble Length | Twenty one (21) bits |
| Int:11b | Preamble Waveform | Square wave as defined in Int:11c |
| Int:11c | Bit Sync Sequence | 20 cycles of 30 µs high, 30 µs low, followed by one cycle 54 µs high, 54 µs low |
| Int:11d | Frame Sync Sequence | 20 cycles of 30 µs high, 30 µs low, followed by one cycle 54 µs high, 54 µs low |
| Int:12 | Scrambling | Not applicable in this mode |
| Int:13 | Bit Transmission Order | Byte: least significant bit (LSB) first - Data: most significant byte first |
| Int:14 | Wake-up Process | Yes |
| Int:15 | Polarization | Omni-directional |

### 6.3.2 Tag to interrogator link

**Table 41 — Tag to interrogator link parameters**

| Ref. | Parameter | Value |
|---|---|---|
| Tag:1 | Operating Frequency range | 433,92 MHz |
| Tag:1a | Default Operating Frequency | 433,92 MHz |
| Tag:1b | Operating Channels | Not applicable in this mode |
| Tag:1c | Operating Frequency Accuracy | +/-20 ppm |
| Tag:1d | Frequency Hop Rate | Not applicable in this mode |
| Tag:1e | Frequency Hop Sequence | Not applicable in this mode |
| Tag:2 | Occupied Channel Bandwidth | 200 kHz |
| Tag:2a | Minimum Receiver Bandwidth | 200 kHz |
| Tag:3 | Transmit Maximum EIRP | 5,6 dBm (peak power) or as allowed by local regulations |
| Tag:4 | Transmit Spurious Emissions | |
| Tag:4a | Transmit Spurious Emissions, In-Band | Not applicable in this mode |
| Tag:4b | Transmit Spurious Emissions, Out of Band | The tag shall transmit in conformance with spurious emissions requirements defined by the country's regulatory authority within which the system is operated. |
| Tag:5 | Transmit Spectrum Mask | Not applicable in this mode |
| Tag:6 | Timing | |
| Tag:6a | Transmit to Receive Turn Around Time | 1 ms |
| Tag:6b | Receive to Transmit Turn Around Time | 1 ms |
| Tag:6c | Transmit Power On Ramp | 1 ms |
| Tag:6d | Transmit Power Down Ramp | 1 ms |
| Tag:7 | Modulation | Frequency Shift Keying (FSK) |
| Tag:7a | Spreading Sequence | Not applicable in this mode |
| Tag:7b | Chip Rate | Not applicable in this mode |
| Tag:7c | Chip Rate Accuracy | Not applicable in this mode |
| Tag:7d | On-Off Ratio | Not applicable in this mode |

**Table 41** *(continued)*

| Ref. | Parameter | Value |
|---|---|---|
| Tag:7e | Sub-carrier Frequency | Not applicable in this mode |
| Tag:7f | Sub-carrier Frequency Accuracy | Not applicable in this mode |
| Tag:7g | Sub-carrier Modulation | Not applicable in this mode |
| Tag:7h | Duty Cycle | Not applicable in this mode |
| Tag:7i | FM deviation | ±35 kHz |
| Tag:8 | Data Coding | Manchester, 36 µs bit period.<br>Logic one: 18 µs low followed by 18 µs high,<br>Logic zero: 18 µs high followed by 18 µs low |
| Tag:9 | Bit Rate | 27,7 kbit/s |
| Tag:9a | Bit Rate Accuracy | 200 ppm |
| Tag:10 | Tag Transmit Modulation Accuracy | Not applicable in this mode |
| Tag:11 | Preamble | |
| Tag:11a | Preamble Length | Twenty one (21) bits |
| Tag:11b | Preamble Waveform | Square wave as defined in Tag:11c |
| Tag:11c | Bit Sync Sequence | 20 cycles of 30 µs high, 30 µs low, followed by one cycle 42 µs high, 54 µs low |
| Tag:11d | Frame Sync Sequence | 20 cycles of 30 µs high, 30 µs low, followed by one cycle 42 µs high, 54 µs low |
| Tag:12 | Scrambling | Not applicable in this mode |
| Tag:13 | Bit Transmission Order | Byte: least significant bit (LSB) first<br>Data: most significant byte first |
| Tag:14 | (Reserved by committee) | |
| Tag:15 | Polarization | Omni-directional |
| Tag:16 | Minimum Tag Receiver Bandwidth | 200 kHz |

### 6.3.3 Protocol parameters

**Table 42 — Protocol parameters**

| Ref. | Parameter Name | Description |
|---|---|---|
| P:1 | Who talks first | Reader-Talks-First (RTF) |
| P:2 | Tag addressing capability | Yes |
| P:3 | Tag UID | Yes |
| P:3a | UID Length | 32 bit |
| P:3b | UID Format | binary |
| P:4 | Read size | 1 to 46 bytes, |
| P:5 | Write Size | 1 to 46 bytes, |
| P:6 | Read Transaction Time | 27,7 kbit/s |
| P:7 | Write Transaction Time | 27,7 kbit/s |
| P:8 | Error detection | CCITT 16 |
| P:9 | Error correction | None |
| P:10 | Memory size | 1 byte, 128 kbytes |
| P:11 | Command structure and extensibility | 8 bits for command |

### 6.3.4 Anti-collision parameters

**Table 43 — Anti-collision parameters**

| Ref. | Parameter Name | Description |
|---|---|---|
| A:1 | Type | Probabilistic |
| A:2 | Linearity (for N tags) | Probabilistic: 0,065*N seconds for 1 <= N <= 3000 |
| A:3 | Tag inventory capacity | Probabilistic: 3000 |

# Bibliography

[1] ISO/IEC Directives, Part 2: *Rules for the structure and drafting of International Standards*, 2001

[2] ISO/IEC 18000-1, *Information technology — Radio frequency identification for item management — Part 1: Reference architecture and definition of parameters to be standardized*

[3] ISO/IEC 18001, *Information technology — Radio frequency identification for item management — Application Requirements Profiles*

[4] ISO/IEC 18046, *Information technology — Automatic identification and data capture techniques — RFID device performance test methods*

[5] ISO/IEC TR 18047-7, *Information technology — Radio frequency identification device conformance test methods — Part 7: Test methods for air interface communications at 433 MHz*

[6] *CCITT Red Book,* Volume VIII, International Telecommunications Union, Geneva, 1986. *Recommendation V.41, Code-Independent Error Control System*

[7] ERC/REC 70-03 — *Relating to the Use of Short Range Devices (SRD),* Annex 1, Band E; European Radiocommunications Committee (ERC), December 2002

[8] US Code of Federal Regulations (CFR) Title 47, Chapter I, Part 15, Section 15.231. “Periodic operation in the band 40.66-40.70 MHz and above 70 MHz”; U.S. Federal Communications Commission, 1 Oct. 1999

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