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ISO/IEC 18000-7

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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 de communications actives d'une interface d'air à 433 MHz

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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 Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

This second edition cancels and replaces the first edition (ISO/IEC 18000-7:2004), which has been technically revised.

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 serial 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 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 ISO and IEC that he is 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.

Patent number	Patent title	Patent holder	Contact	Affected subclause
US 5640151	Communication System for Communicating with Tags	Savi Technology	Ravi Rajapaksi, Chief Technology Officer, Savi Technology, Inc., 615 Tasman Dr., Sunnyvale, CA 94089, USA	6.2.6
US 5686902	Communication System for Communicating with Tags	Savi Technology	Ravi Rajapaksi, Chief Technology Officer, Savi Technology, Inc., 615 Tasman Dr., Sunnyvale, CA 94089, USA	6.2.6
EP 0467036	Method and Apparatus for Radio Identification and Tracking	Savi Technology	Ravi Rajapaksi, Chief Technology Officer, Savi Technology, Inc., 615 Tasman Dr., Sunnyvale, CA 94089, USA	6.2.6
US 6002344	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2
CA 2,310,623	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2

CN 98812462.9	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2
DE 98960332.9	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2
EP 98960332.9	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2
FR 98960332.9	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2
GB 98960332.9	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2
HK 01101416.3	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2
IL 136.220	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2
IT 98960332.9	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2
JP 2000-521687	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2
US 7,035,818	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2
US 10/725,010	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2
US 10,932,279	System and method for electronic inventory	Symbol Technologies	Aaron B. Bernstein, VP, Deputy General Counsel Intellectual Property, 1 Motorola Plaza, MS A6, Holtsville, NY 11561	6.2
US 6,470.045	Communication protocol between a transceiver unit and transponders or transceiver with said unit / V.Fuentes	EM Microelectronics Marin SA	G. Meusburger, IP Manager, Rue des Sors, CH-2074, Marin, Switzerland	
JP 10-256493	Communication protocol between a transceiver unit and transponders or transceiver with said unit / V.Fuentes	EM Microelectronics Marin SA	G. Meusburger, IP Manager, Rue des Sors, CH-2074, Marin, Switzerland	
EP 0 902 546 Appl. No. 97115772.2	Communication protocol between a transceiver unit and transponders or transceiver with said unit / V.Fuentes	EM Microelectronics Marin SA	G. Meusburger, IP Manager, Rue des Sors, CH-2074, Marin, Switzerland	

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 interoperability 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 are defined in 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 15459 (all parts), *Information technology — Unique identifiers*

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

ISO 17363, *Supply chain applications of RFID — Freight containers*

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

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

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

ITU-T Recommendation V.41, *Code-independent error-control system*

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 shall utilize a narrow band UHF frequency with the following characteristics:

Carrier Frequency	433,92 MHz +/-20ppm
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	31,25 kHz sub-carrier tone followed by 10 kHz tone

The Wake up signal shall be transmitted by the interrogator for a minimum of 2,4 seconds to wake up all tags within communication range. The wake up signal shall consist of a 2,4- to 4,8-second 31,25 kHz sub-carrier tone followed by a 0,1-second 10 kHz sub-carrier tone. Upon detection of the Wake-up signal all tags shall enter into the Ready state awaiting a command from the interrogator. See Figure 1. Once woken up, the tag shall stay awake for 30 seconds after the last command received, unless the interrogator otherwise commands the tag.

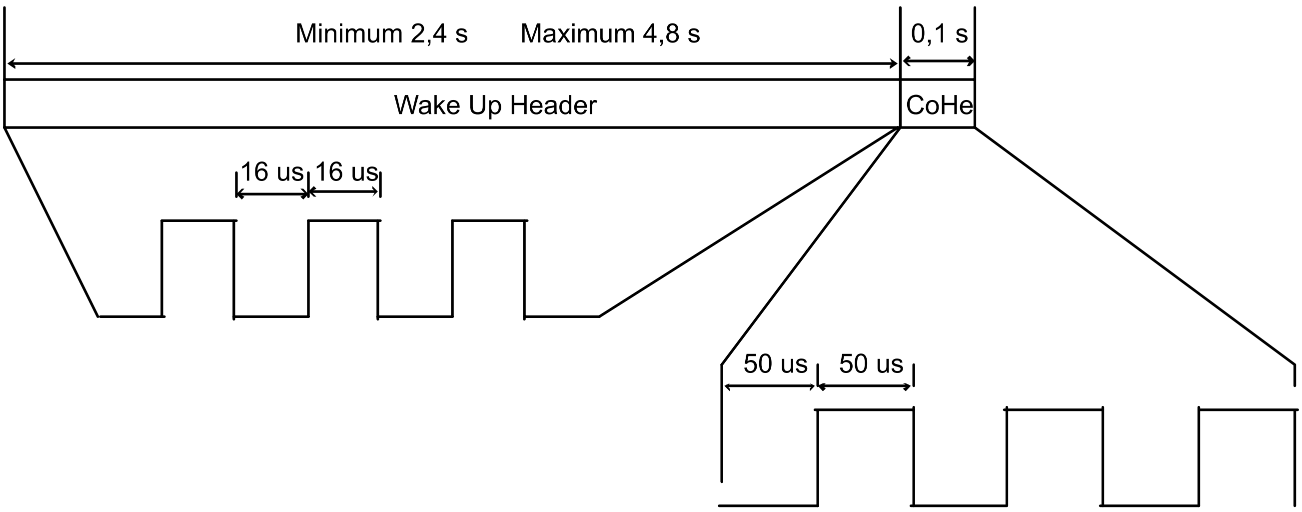


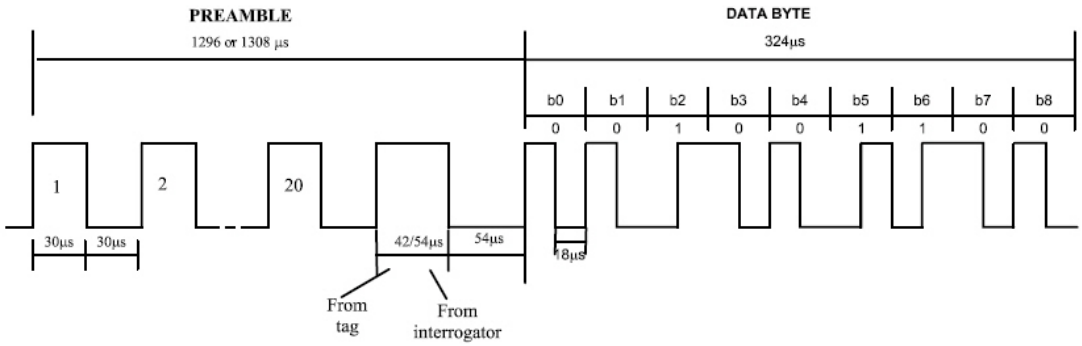
Figure 1 — Wake-up header

The communication between interrogator and tag shall be of the Master-Slave type, where the interrogator shall initiate communications and then listen for a response from a tag. Multiple response transmissions from tags shall be controlled by the collection algorithm described in section 6.4.

6.2 Data link layer

6.2.1 General

Data between interrogator and tag shall be transmitted in packet format. A packet shall be comprised of a preamble, data bytes and a final logic low period. The last two pulses of the preamble shall indicate the end of the preamble and beginning of the first data byte. The same two pulses of the preamble also indicate the originator of the data packet. Data bytes shall be sent in Manchester code format. Transmission order shall be most significant byte first; within a byte, the order shall be least significant bit first. Figure 2 illustrates the data communication timing of the preamble and the first byte of a packet.



Note: Data byte transmitted order is most significant byte first; with a byte the order is least significant bit first. Byte shown is code 0x64.

Figure 2 — Data communication timing

6.2.2 Preamble

The preamble shall be 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); or 54 µs high, 54 µs low (interrogator to tag).

6.2.3 Data byte format

Data bytes shall be in Manchester code format, comprised of 8 data bits and one stop bit. The bit period shall be 36 µs, the total byte period shall be 324 µs. A falling edge in the centre 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 shall be calculated as a 16-bit value, initialized with all zeroes (0x0000), over all data bytes (excluding preamble) according to the CCITT polynomial ($x^{16} + x^{12} + x^5 + 1$). The CRC shall be appended to the data as two bytes. Reference: ITU-T Recommendation V.41 (Extract from the *Blue Book*), *Code-independent error-control system,* Appendix I - *Encoding and decoding realization for cyclic code system.*

6.2.5 Packet end period

A final period of 36 µs of continuous logic low shall be transmitted after the last Manchester encoded bit within the packet.

6.2.6 Interrogator-to-tag message format

Tags shall recognize the interrogator-to-tag message format described in Tables 1 and 2.

Table 1 — Interrogator-to-tag command format (broadcast)

Protocol ID	Packet Options	Packet Length	Interrogator ID	Command Code	Command Arguments	CRC
0x40	1 byte	1 byte	2 bytes	1 byte	N bytes	2 bytes

Table 2 — Interrogator-to-tag command format (point-to-point)

Protocol ID	Packet Options	Packet Length	Tag Manufacturer ID	Tag Serial Number	Interrogator ID	Command Code	Command Arguments	CRC
0x40	1 byte	1 byte	2 bytes	4 bytes	2 Bytes	1 byte	N bytes	2 bytes

6.2.6.1 Packet options

Table 3 — Packet options field

Bit							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Reserved	Reserved	Reserved	Reserved	Reserved	1	0= Broadcast (Tag serial number and Tag manufacturer ID not present) 1= Point to Point (Tag serial number and tag manufacturer ID present)	Reserved

The Packet Options field, described in Table 3, shall be is used to indicate the presence of the Tag serial number and Tag manufacturer fields within the current data packet. If the interrogator wishes to address a single tag by specifying its Tag serial number, Bit 1 of the Packet Options field shall be set, indicating point-to-point communication. In the case in which the interrogator wants to address all tags within its RF communication range, Bit 1 of the Packet Options field shall be cleared to indicate a broadcast message. A broadcast message shall not use the Tag serial number field, which is omitted from the data packet. Reserved bits are for future use. The default value shall be “0”.

6.2.6.2 Protocol ID

The protocol ID field allows different application standards based on ISO/IEC 18000-7 (“derived application standards”) to be developed. All derived application standards shall share the same physical layer protocols, but their command/response structure/field and command sets may vary depending on the application. The two basic commands “collection” (i.e., collection with Universal Data Block)” and “sleep and sleep all but” defined in this standard shall be supported by all derived application standards. All other commands required by this standard shall be supported by 18000-7 compliant products, but not necessary by products compliant with derived application standards.

When the interrogator sends out a wake up signal, all tags based on the ISO/IEC 18000-7 air interface and derived standards shall wake up.

The interrogator may send out various commands as specified by the application. In the event that the interrogator wants to inventory all the active tags within its range, it shall send out a Collection command as defined in this standard. All tags adhering to ISO/IEC 18000-7 or derived application standards shall respond to this basic Collection command. A tag shall respond with the collection response defined by the tag's own application data link layer standard (ISO/IEC 18000-7 or derived standard). The tags shall also accept the Sleep commands defined in this standard. The co-existence of ISO/IEC 18000-7 and derived standards is illustrated in Annex A.

In this standard, the collection command is Collection with Universal Data Block. In the following section, collection command and Collection with Universal Data Block are used interchangeably.

6.2.6.3 Tag Manufacturer ID

The Tag Manufacturer ID is a unique identifier that is issued to each tag manufacturer. The Tag Manufacturer ID is a 16-bit code assigned by the Registration Authority as called out in ISO/IEC 15963. This 16 bit code is a combination of the 15963 Allocation Class “0001 0001” and the 8-bit Issuer UID “xxxxxxxx”.

6.2.6.4 Tag Serial Number

The Tag Serial Number is a 32-bit integer that is uniquely assigned to each individual tag during manufacturing. This number cannot be changed and is read only. The Tag Serial Number has no structure and does not contain any information besides uniquely identifying a tag. The Tag Serial Number cannot be reused. Issuance of Tag Serial Numbers may be managed and administered by each manufacturer. The Tag Manufacturer ID and Tag Serial Number together uniquely identify a tag as defined in ISO/IEC 15963. The Tag Serial Number for each manufacturer is four bytes in length. An example of the combined data structure for Tag Manufacturer ID and Tag Serial Number is:

00000001 00010001 xxxxxxxx xxxxxxxxx xxxxxxxx xxxxxxxxx

6.2.6.5 Interrogator ID

The Interrogator ID is a 16-bit integer programmed into the interrogator's non-volatile memory. The Interrogator ID, which can be changed without restriction, is used to route tag responses efficiently through an interrogator network. At the moment the Interrogator ID is changed in an interrogator, any ongoing communication between that interrogator and any tag shall be terminated. An interrogator that receives a tag message containing an Interrogator ID not equal to the Interrogator ID of that interrogator shall not pass the message to the system.

6.2.6.6 Command codes

The Command codes and their function as a Read and/or Write command shall be as listed in Table 4, below. The least significant 7 bits of a command identify its base function; the eighth (MS) bit is set to “0” for a Read function and “1” for a Write function. Codes not identified are reserved. All commands are mandatory unless otherwise specified.

Table 4 — Command codes

Command code (R / W)	Command name	Command type	Mandatory/Optional		Description
			Interrogator	Tag	
0x1F / NA	Collection with Universal Data Block	Broadcast	Mandatory	Mandatory	Collects all Tag IDs and Universal Data Block
NA / 0x15	Sleep	Point to Point	Mandatory	Mandatory	Puts tag to sleep
NA / 0x16	Sleep All But	Broadcast	Mandatory	Mandatory	Puts all tags but one to sleep
0x13 / 0x93	User ID	Point to Point	Mandatory	Optional	Sets user assigned ID (1 – 60 bytes)
0x09 / 0x89	Routing Code	Point to point	Mandatory	Mandatory	Reads and writes routing code
0x0C / NA	Firmware Revision	Point to Point	Mandatory	Optional	Retrieves manufacturer-defined tag firmware revision number
0x0E / NA	Model Number	Point to Point	Mandatory	Optional	Retrieves manufacturer-defined tag model number
0x60 / 0xE0	Read/Write Memory	Point to Point	Mandatory	Optional	Reads and writes user memory
NA / 0x95	Set Password	Point to Point	Mandatory	Optional	Sets tag password (4 bytes long)
0x17 / 0x97	Set Password protect	Point to Point	Mandatory	Optional	Engages/disengages password protection (see section 6.3.4)
NA/ 0x96	Unlock	Point to Point	Mandatory	Optional	Unlocks password protected tag
0x70 / NA	Read Universal Data Block	Point to Point	Mandatory	Mandatory	Reads the Universal Data Block
0x26	Table Create	Point to Point	Mandatory	Optional	Creates a database table
0x26	Table Add Records	Point to Point	Mandatory	Optional	Prepares to add new records to the specified database table
0x26	Table Update Records	Point to Point	Mandatory	Optional	Prepares to modify the specified table records
0x26	Table Update Fields	Point to Point	Mandatory	Optional	Prepares to update the specified fields of a table record
0x26	Table Delete Record	Point to Point	Mandatory	Optional	Deletes existing record from the existing database table
0x26	Table Get Data	Point to Point	Mandatory	Optional	Prepares to retrieve the specified table records
0x26	Table Get Properties	Point to Point	Mandatory	Optional	Gets total number of records and size of each field
0x26	Table Read Fragment	Point to Point	Mandatory	Optional	Retrieves a block of data from a table as initiated by the Table Get Data command
0x26	Table Write Fragment	Point to Point	Mandatory	Optional	Writes a block of data into a table as initiated by the Table Add Records, Table Update Records, or Table Update fields command
0x26	Table Query	Point to Point	Mandatory	Optional	Initiates table search based on the specified criteria
0x11 / NA	Collection Query	Broadcast	Mandatory	Optional	Requests results from Table Query
0xE1 / NA	Beep ON/OFF	Point to Point	Mandatory	Optional	Turns tag's beeper ON or OFF
0x8E	Delete Writeable Data	Point to Point	Mandatory	Optional	Deletes all allocated writeable data on a tag

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

6.2.6.7 Command arguments

Some commands require additional argument. For those commands where argument is defined, additional data must be supplied with the command. The value of N, which may be zero, and the nature of the data are specific to each command. See section 6.3 for details.

6.2.7 Tag-to-interrogator message format

The tag-to-interrogator message shall use one of two formats depending on the type of message being transmitted to the Interrogator. The tag shall always respond to a command using one of the response formats described below except in the following situations, for which the tag shall not respond:

- the command is explicitly specified in this standard as requiring no response;
- the CRC bytes received in the command do not match the CRC checksum that the tag has calculated for the received command packet.

There are two possible response formats:

- the Broadcast response message format;
- the Point-to-Point response message format.

6.2.7.1 Broadcast response message format

The message format shown in Table 5 shall be used in response to Interrogator broadcast commands received by tags within the Interrogator's communication range.

The broadcast command shall be used to collect Tag Manufacturer IDs, Tag Serial Numbers, Routing Codes and optionally application data from the selected group of tags using the batch collection algorithm. See 6.3.1 for more details.

Table 5 — Broadcast response message format

Protocol ID	Tag Status	Packet Length	Interrogator ID	Tag Manufacturer ID	Tag Serial Number	Command Code	Data	CRC
0x40	2 bytes	1 byte	2 bytes	2 bytes	4 bytes	1 byte	N bytes	2 bytes

Tag Status: Indicates various conditions such as response format, tag type, and alert flag. See section 6.2.7.4, **Tag Status,** for more details.

Packet Length: Message length in bytes including CRC byte codes

Interrogator ID: ID of Interrogator: Integer value from 1 to 65535

Tag Manufacturer ID: Unique ID assigned to manufacturer

Tag Serial Number: Unique tag serial number preset during manufacturing

Command Code: Command code (see Table 4) received from the Interrogator

Data: Contains the Universal Data Block that includes the mandatory Routing Code and optionally application data (see Table 6). N is the size, in bytes, of the Universal Data Block.

CRC: CCITT code check bytes

Table 6 — Type ID values

Type ID (1 byte)		Note
0x00 - 0x0A	Reserved	
0x10	Routing code	The routing code is specified in ISO 17363
0x11	User ID	User ID as specified within this document
0x12 – 0x7F	Reserved	These types are reserved for future tag data elements
0x7F – 0xFF	Future extension	Also reserved

6.2.7.2 Point-to-point response message format

This message format, shown in Table 7, shall be returned to the Interrogator as a response to all point-to-point commands, which require the Tag Serial Number in order to access a particular tag. (The point-to-point commands include all commands except Collection commands).

Table 7 — Tag-to-interrogator response format (point-to-point)

Protocol ID	Tag Status	Packet Length	Interrogator ID	Tag Manufacturer ID	Tag Serial Number	Command Code	Response Data*	CRC
0x40	2 bytes	1 byte	2 bytes	2 bytes	4 bytes	1 byte	N bytes	2 bytes

* This field is command dependent; some commands may or may not need this field

Tag Status: Indicates various conditions such as response format, tag type, and alert flag. See section 6.2.7.4, **Tag Status,** for more details.

Packet Length: Message length in bytes including CRC byte codes.

Interrogator ID: ID of Interrogator, an Integer value from 1 to 65535.

Tag Manufacturer ID: Unique ID assigned to manufacturer.

Tag Serial Number: Unique tag serial number preset during manufacturing.

Command Code: Command code received from the Interrogator.

Response Data: Data returned by the tag as a response to an Interrogator's valid command request. The value of N, the length of the data in bytes, is specific to the command. In the event that the tag receives an invalid command, a NACK flag within the Tag Status word will be set and the Response Data will contain an error code of one or more bytes, as described in Table 8.

CRC: CCITT code check bytes.

6.2.7.3 Error codes

In response to a point-to-point command a tag may reply with one of the errors listed in Table 8. Errors generated resulting from broadcast commands do not generate responses.

Table 8 — Error code

Error Code	Description
0x01	Invalid Command Code
0x02	Invalid Command Parameter
0x04	Not Found
0x06	Can't Create Object
0x08	Authorization Failure
0x09	Object is Read-Only
0x3f	Implementation Dependent
0x40	Sequence ID Mismatch
0x41	Boundary Exceeded

An error shall consist of a one-byte error code; possibly a one-byte sub-code, depending on the kind of error; possibly one or more bytes of parameter data, also depending on the error; and an optional, manufacturer-defined number of additional data bytes, as shown in Table 9. In the following error definition sections, the optional, manufacturer-defined data bytes are not shown.

Table 9 — General error format

Error Code	Sub-code	Error Data	Manufacturer Data
1 byte	1 byte	N bytes	M bytes

Error Code: a value from Table 8 identifying the kind of error

Sub-code: an optional value that further refines the nature of the error and is specific to the kind error, as defined in the following subsections

Error Data: N bytes of data, where N is zero or greater, whose existence, length, and content depend on the nature of the error, as defined in the following subsections

Manufacturer Data: M bytes of data, where M is zero or greater, whose existence, length, and content are at the discretion of the tag manufacturer

6.2.7.3.1 Invalid command code error

Table 10 shows the structure of this error code.

Table 10 — Invalid command code error

Error Code
0x01

This error as defined in Table 10 shall be generated when the tag receives a packet with a command code or class code that is not defined in this standard.