

Australian Standard[®]

**Information technology—Radio
frequency identification for item
management**

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



This Australian Standard® was prepared by Committee IT-034, Automatic Identification and Data Capture Techniques. It was approved on behalf of the Council of Standards Australia on 15 November 2006.

This Standard was published on 23 January 2007.

The following are represented on Committee IT-034:

- Australian Custom Service
 - Australian Data Capture Association
 - Australian Electrical and Electronic Manufacturers Association
 - Australian Retailers Association
 - Australian Veterinary Association
 - Department of Communications, Information Technology and the Arts
 - Department of Defence
 - Department of Primary Industries, Vic
 - GS1 Australia
 - RFID Association of Australia
 - The University of Adelaide
-

This Standard was issued in draft form for comment as DR 06536.

Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through public comment period.

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Australian Standard[®]

Information technology—Radio frequency identification for item management

Part 2: Parameters for air interface communications below 135 kHz

First published as AS ISO/IEC 18000.2—2007.

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Published by Standards Australia GPO Box 476, Sydney, NSW 2001, Australia

ISBN 0 7337 7968 9

PREFACE

This Standard was prepared by the Standards Australia Committee IT-034, Automatic Identification and Data Capture Techniques.

The objective of this Standard is to provide a common technical specification for RFID devices operating below 135 kHz to allow for compatibility and to encourage inter-operability of products for the growing RFID market in the international marketplace.

This Standard is identical with, and has been reproduced from ISO/IEC 18000-2:2004, *Information technology—Radio frequency identification for item management—Part 2: Parameters for air interface communications below 135 kHz*

As this Standard is reproduced from an International Standard, the following applies:

- (a) Its number appears on the cover and title page while the International Standard number appears only on the cover.
- (b) In the source text ‘this part of ISO/IEC 18000’ should read ‘this Australian Standard’.
- (c) A full point substitutes for a comma when referring to a decimal marker.

References to International Standards should be replaced by references to Australian or Australian/New Zealand Standards, as follows:

<i>Reference to International Standard</i>		<i>Australian Standard</i>	
ISO		AS	
11784	Radio frequency identification of animals—Code structure	5018	Electronic animal identification — National coding scheme (ISO 11784:1996, MOD)
11785	Radio frequency identification of animals—Technical concept	5019	Electronic animal identification—Radiofrequency methods
ISO/IEC		AS ISO/IEC	
15418	Information technology—EAN/UCC Application Identifiers and Fact Data Identifiers and Maintenance	15418	Information technology— EAN/UCC Application Identifiers and Fact Data Identifiers and Maintenance
15961	Information technology—Radio frequency identification (RFID) for item management—Data protocol: application interface	15961	Information technology—Radio frequency identification (RFID) for item management—Data protocol: application interface
15962	Information technology—Radio frequency identification (RFID) for item management—Data protocol: data encoding rules and logical memory functions	15962	Information technology—Radio frequency identification (RFID) for item management—Data protocol: data encoding rules and logical memory functions
18000-1	Information technology—Radio frequency identification for item management—Part 1: Reference architecture and definition of parameters to be standardized	18000.1	Information technology—Radio frequency identification for item management—Part 1: Reference architecture and definition of parameters to be standardized

ISO/IEC

19762 Information technology—Automatic
(all identification and data capture
parts) (AIDC) techniques—Harmonized
vocabulary

AS ISO/IEC

19762 Information technology—Automatic
(all identification and data capture
parts) (AIDC) techniques—Harmonized
vocabulary

Only international references that have been adopted as Australian or Australian/New Zealand Standards have been listed.

The term ‘informative’ has been used in this Standard to define the application of the annex to which it applies. An ‘informative’ annex is only for information and guidance.

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INTRODUCTION

ISO/IEC 18000 is a series of International Standards describing common communications protocols for the purpose of Radio Frequency Identification for Item Management.

This part of ISO/IEC 18000 relates to systems operating at frequencies less than 135 kHz.

It has been developed in accordance with the requirements determined in ISO 18000-1, *Information technology — Radio frequency identification for item management — Reference architecture and definition of parameters to be standardized*.

AUSTRALIAN STANDARD

Information technology — Radio frequency identification for item management —**Part 2:
Parameters for air interface communications below 135 kHz****1 Scope**

This part of ISO/IEC 18000 defines the air interface for radio frequency identification (RFID) devices operating below 135 kHz used in item management applications. Its purpose is to provide a common technical specification for RFID devices to allow for compatibility and to encourage inter-operability of products for the growing RFID market in the international marketplace. This part defines the forward and return link parameters for technical attributes including, but not limited to, operating frequency, operating channel accuracy, occupied channel bandwidth, spurious emissions, modulation, duty cycle, data coding, bit rate, bit rate accuracy, bit transmission order. It further defines the communications protocol used in the air interface.

This part contains two types. The detailed technical differences between the types are shown in the parameter tables.

This part of ISO/IEC 18000 specifies

- The physical layer that is used for communication between the interrogator and the tag.
- The protocol and the commands
- The method to detect and communicate with one tag among several tags (“anti-collision”)

It specifies two types of tags: Type A (FDX) and Type B (HDX). These two types differ only by their physical layer. Both types support the same anti-collision and protocol.

FDX tags are permanently powered by the interrogator, including during the tag-to-interrogator transmission. They operate at 125 kHz.

HDX tags are powered by the interrogator, except during the tag-to-interrogator transmission. They operate at 134,2 kHz. An alternative operating frequency is described in Annex B.

An optional anti-collision mechanism is described in Annex D.

2 Conformance**2.1 Tag**

To claim conformance with this part of ISO/IEC 18000, a tag shall be of either Type A or B.

NOTE Nothing in this part of ISO/IEC 18000 prevents a tag to be of both types, although for technical reasons, it is unlikely that such tags are ever marketed.

2.2 Interrogator

To claim conformance with this part of ISO/IEC 18000, an interrogator shall support both Types A and B.

Depending on the application, it may be configured as Type A only, Type B only or Types A and B.

When configured in Types A and B, and when in the Inventory phase, the interrogator shall alternate between Type A and Type B interrogation. See Annex C.

NOTE The rules for RFID device (tag and interrogator) conformity evaluation will be given in a future Technical Report (ISO/IEC TR 18047-2).

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 7816-6, *Identification cards — Integrated circuit cards — Part 6: Interindustry data elements for interchange*

ISO/IEC 15418, *Information technology — EAN/UCC Application Identifiers and Fact Data Identifiers and Maintenance*

ISO 11784, *Radio frequency identification of animals — Code structure*

ISO 11785, *Radio frequency identification of animals — Technical concept*

ISO/IEC 15961, *Information technology — Radio frequency identification for item management — Data protocol: application interface¹⁾*

ISO/IEC 15962, *Information technology — Radio frequency identification for item management — Data protocol: data encoding rules and logical memory functions¹⁾*

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

ISO/IEC 19762 (all parts), *Information technology — Automatic identification and data capture techniques — Harmonized vocabulary¹⁾*

4 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms, definitions, symbols and abbreviated terms given in ISO/IEC 19762 (all parts) and the following apply.

4.1 Terms and definitions

4.1.1

anti-collision loop

algorithm used to prepare for and handle a dialogue between interrogator and one or more tags out of several in its energizing field

4.1.2

byte

8 bits of data designated b1 to b8, from the most significant bit (MSB, b8) to the least significant bit (LSB, b1)

1) To be published.

4.2 Symbols

All symbols are expressed with a letter, followed by a upper case letter (A or B or D when referring respectively to the Type A or Type B or Annex D, p when referring to the protocol), followed by letters and/or numbers as appropriate. The main symbols are listed below, where X represents A or B or D. Timings are expressed with an upper case T and according to above rule. Other symbols specific to A, B or D are specified in the relevant clauses.

f_{xc}	Carrier frequency of the operating field
T_{xd0}	Period of Data Symbol "0"
T_{xd1}	Period of Data Symbol "1"
T_{xc}	Period of carrier frequency ($T_{xc} = 1/f_{xc}$)
T_{xcv}	Code Violation Duration

4.3 Abbreviated terms

ACL	Allocation class
ASK	Amplitude shift keying
AFI	Application family identifier
BSS	Block security status
BWP	Block write protection
CRC	Cyclic redundancy check
CRCT	Response cyclic redundancy check flag
DSFID	Data storage format identifier
EOF	End of frame
FDX	Full duplex
HDX	Half duplex
IRC	IC reference code
LSB	Least significant bit
MFC	Manufacturer code
MSB	Most significant bit
MSN	Manufacturer serial number
NOB	Number of blocks
NOS	Number of slots
NRZ	Non return to zero
RF	Radio frequency
RFU	Reserved for future use
SOF	Start of frame
SUID	Sub unique identifier (includes MFC and MSN)
UID	Unique Identifier (includes ACL, MFC and MSN)

5.1.3.2 Data rate and data coding

The interrogator-to-tag communication uses Pulse interval encoding. The interrogator creates pulses by switching the carrier as described in Figure 1. The time between the falling edges of the pulses determines either the value of the data bit "0" and "1", a Code violation or a Stop condition.

Assuming equal distributed data bits "0" and "1", the data rate is in the range of 5,1 kbit/s.

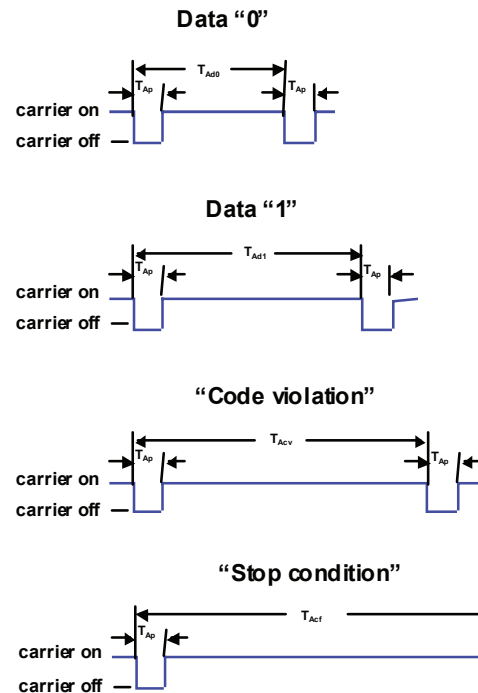


Figure 2 — Interrogator to tag: Pulse interval encoding

Table 2 — Data coding Times

Meaning	Symbol	min	max
"Carrier off" time	T_{Ap}	$4 * T_{Ac}$	$10 * T_{Ac}$
Data "0" time	T_{Ad0}	$18 * T_{Ac}$	$22 * T_{Ac}$
Data "1" time	T_{Ad1}	$26 * T_{Ac}$	$30 * T_{Ac}$
"Code violation" time	T_{Acv}	$34 * T_{Ac}$	$38 * T_{Ac}$
"Stop condition" time	T_{Asc}	$\geq 42 * T_{Ac}$	n/a

NOTE $T_{Ac} = 1/f_{Ac} \approx 8 \mu s$.

5.1.3.3 Start of frame pattern

The interrogator request starts always with a Start of frame pattern (SOF) for ease of synchronization. The SOF pattern consists of a data bit "0" pattern and a "Code violation" pattern.

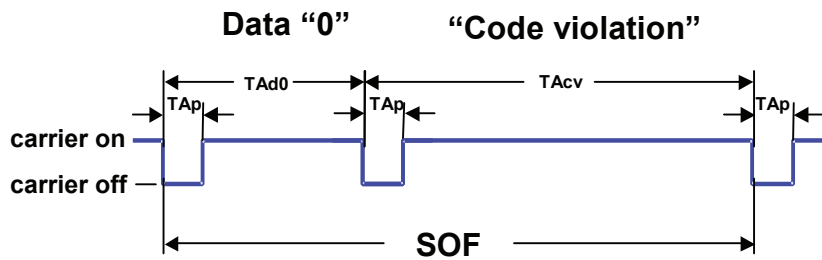


Figure 3 — Start of frame pattern

The tag shall be ready to receive a SOF from the interrogator within 1,2 ms after having sent a response to the interrogator.

The tag shall be ready to receive a SOF from the interrogator within 2,5 ms after the interrogator has established the powering field.

5.1.3.4 End of frame pattern

For slot switching during a multislot anti-collision sequence, the interrogator request is an EOF pattern. The EOF pattern is represented by a "Stop condition".

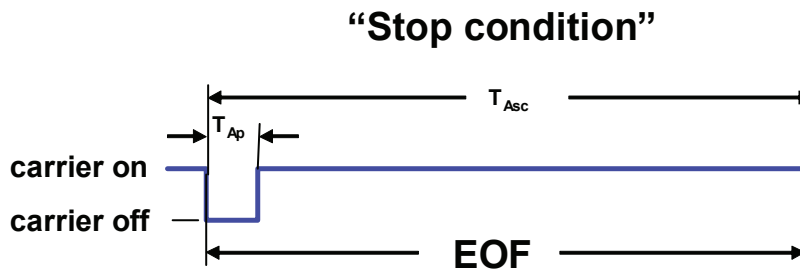


Figure 4 — End of frame pattern

5.1.4 Communication signal interface tag to interrogator

5.1.4.1 Data rate and data coding

The tag shall be capable to communicate with the interrogator via an inductive coupling, whereby the carrier is loaded with

- a 4 kbit/s Manchester coded data signal on the International Standard commands
- a 2 kbit/s dual pattern data coding on the INVENTORY command

NOTE The slower data rate used during the inventory process allows for improving the collision detection when several tags are present in the interrogator field, especially if some tags are in the near field and others in the far field.

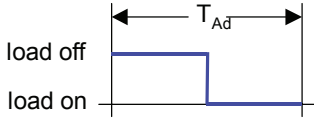
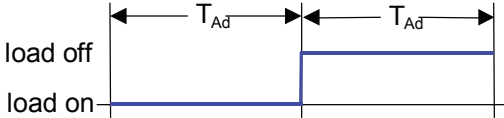
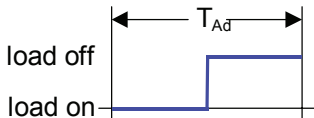
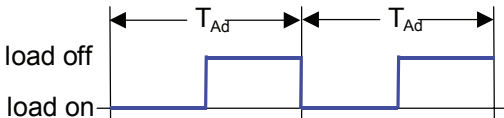
Data Element	International Standard command	Inventory command
Data "0"		
Data "1"		

Figure 5 — Tag to interrogator: load modulation coding

5.1.4.2 Start of frame pattern

The tag response starts always with a Start of frame (SOF) pattern. The SOF pattern is a Manchester coded bit sequence of "110".

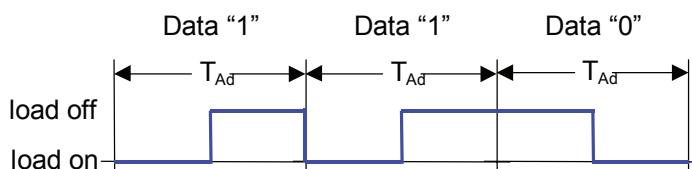


Figure 6 — Start of frame pattern

5.1.4.3 End of frame pattern

No EOF is used nor specified for the tag response.

5.2 Type B (HDX)

5.2.1 Power transfer

Power transfer to the tag is accomplished by radio frequency via coupling antennas in the tag and in the interrogator. The RF operating field supplies power at the beginning of the request from the interrogator to the HDX tag. For communication between interrogator and tag, the field is modulated.

5.2.1.1 Frequency

The carrier frequency of the RF operating field is $f_{Bc} = 134,2$ kHz or as described in Annex B.

5.2.2 Communication signal interface interrogator to tag

5.2.2.1 Modulation

Communication between interrogator and tag takes place using ASK modulation with a modulation index of 100%.

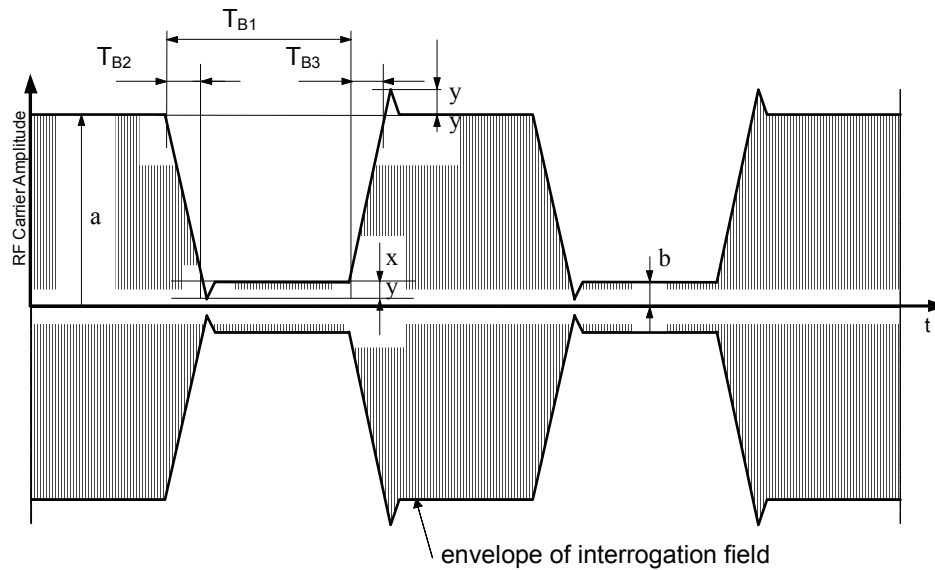


Figure 7 — Modulation details of data transmission from interrogator to tag

Table 3 — Modulation coding times

Symbol	Fast data rate			Slow data rate		
	min	nom	max	min	nom	max
T_{B1}	$11 * T_{Bc}$	$13 * T_{Bc}$	$18 * T_{Bc}$	$11 * T_{Bc}$	$13 * T_{Bc}$	$25 * T_{Bc}$
T_{B2}	$2 * T_{Bc}$	$7 * T_{Bc}$	$10 * T_{Bc}$	$2 * T_{Bc}$	$7 * T_{Bc}$	$10 * T_{Bc}$
T_{B3}	$5 * T_{Bc}$	$25 * T_{Bc}$	$32 * T_{Bc}$	$5 * T_{Bc}$	$100 * T_{Bc}$	$115 * T_{Bc}$
x	0	n/a	$0,15 * a$	0	n/a	$0,15 * a$
y	0	n/a	$0,05 * a$	0	n/a	$0,05 * a$

5.2.2.2 Data rate and data coding

The interrogator-to-tag communication uses Pulse interval encoding. The interrogator creates pulses by switching the carrier as described in Figure 7. The time between the falling edges of the pulses determines either the value of the data bit "0" and "1", a Code violation or a Stop condition.

Assuming equal distribution of data bits "0" and "1", the data rates are:

Slow data rate: 1 kbit/s

Fast data rate: 2,3 kbit/s.

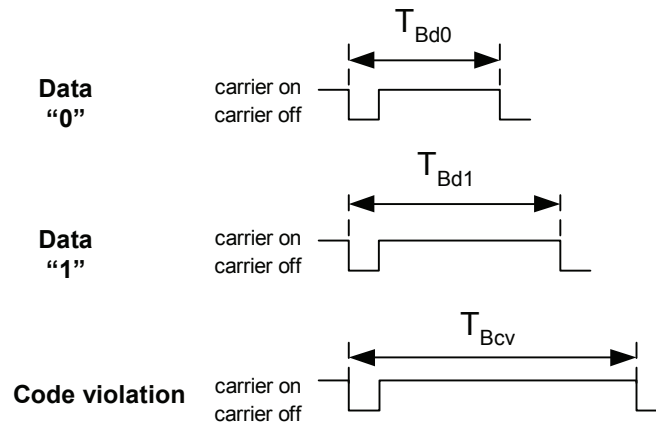


Figure 8 — Interrogator to tag: modulation and coding

Table 4 — Data coding times

Symbol	Fast data rate			Slow data rate		
	min	nom	Max	min	nom	max
T_{Bd0}	$42 * T_{Bc}$	$47 * T_{Bc}$	$52 * T_{Bc}$	$110 * T_{Bc}$	$120 * T_{Bc}$	$130 * T_{Bc}$
T_{Bd1}	$62 * T_{Bc}$	$67 * T_{Bc}$	$72 * T_{Bc}$	$140 * T_{Bc}$	$150 * T_{Bc}$	$160 * T_{Bc}$
T_{Bcv}	$175 * T_{Bc}$	$180 * T_{Bc}$	$185 * T_{Bc}$	$200 * T_{Bc}$	$210 * T_{Bc}$	$220 * T_{Bc}$

NOTE $T_{Bc} = 1/f_{Bc} \approx 7,452 \mu s$

5.2.2.3 Start of frame pattern

The interrogator request starts always with a Start of frame (SOF) pattern. The SOF pattern consists of Data "1", Data "0" and "Code violation" pattern that define a clear start of frame. The difference in duration as specified in Table 4 informs the tag about the requested data rate.

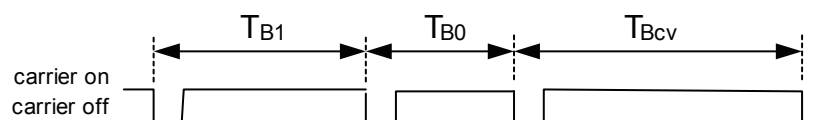


Figure 9 — Start of frame pattern

5.2.2.4 End of frame

The EOF of an interrogator request is defined as the falling edge of the field followed by a delay time longer than T_{B1} .

For the 16 slots inventory sequence, the EOF that instructs the tags to switch to the next slot is defined as the rising edge of the interrogator field followed by a time t_{RCH} .

In both cases, the tag shall receive this sequence before transmitting its response SOF.

5.2.3 Communication signal interface tag to interrogator

5.2.3.1 Data rate and data coding

The tag shall be capable to communicate with the interrogator via an inductive coupling, whereby the power is switched off and the data are FSK modulated using the frequencies:

- $f_{Bc} = 134,2 \text{ kHz}$ for the "Low Bit" encoding
- $f_{B1} = 123,7 \pm 4,2 \text{ kHz}$ for the "High Bit" encoding

The data coding is based on the NRZ method.

The average data rate is 8 kbit/s.

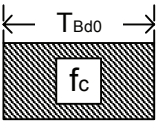
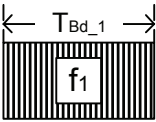
Data Element	International Standard command	Comment
Data "0"		$T_{Bd0} = 16/f_{Bc}$
Data "1"		$T_{Bd1} = 16/f_{B1}$

Figure 10 — Tag to interrogator: modulation and coding

5.2.3.2 Start of frame pattern

The tag response starts always with a Start of frame (SOF) pattern. The SOF pattern is coded with a bit pattern of "111101".

f_{B1} represents the frequency for data bit "1" (T_{Bd1}) and f_{Bc} for data bit "0" (T_{Bd0}).

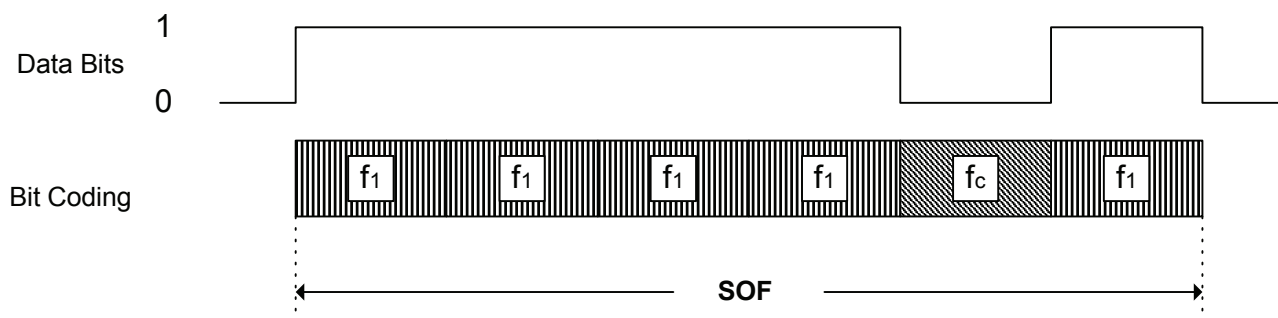


Figure 11 — Start of frame pattern

5.2.3.3 End of frame pattern

The tag response ends always with an End of frame (EOF) pattern. The EOF pattern is coded with a bit pattern of "101111".

f_{B1} represents the frequency for data bit "1" (T_{Bd1}) and f_{Bc} for data bit "0" (T_{Bd0}).

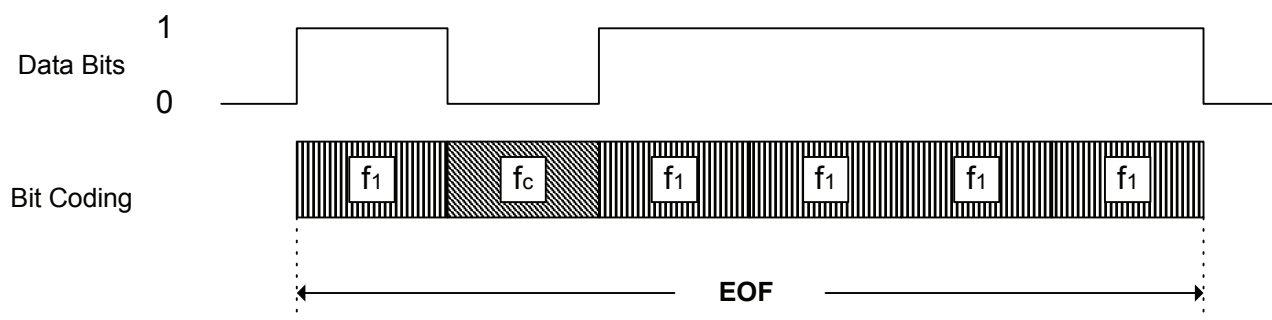


Figure 12 — End of frame pattern

5.3 Physical and Media Access Control (MAC) Parameters

5.3.1 Interrogator to tag link

Ref.	Parameter	Description Type A	Description Type B	Options/Comments
M1-INT: 1	Operating Frequency Range	One interrogator to tag link channel at 125 kHz	One interrogator to tag link channel at 134,2 kHz	
M1-INT: 1a	Default Operating Frequency	125 kHz	134,2 kHz	
M1-INT: 1b	Operating Channels (for Spread Spectrum systems)	Not appropriate for this MODE		
M1-INT: 1c	Operating Frequency Accuracy	Within $\pm 0,1$ kHz		
M1-INT: 1d	Frequency Hop Rate (for Frequency Hopping [FHSS] systems)	Not appropriate for this MODE		
M1-INT: 1e	Frequency Hop Sequence (for Frequency Hopping [FHSS] systems)	Not appropriate for this MODE		
M1-INT: 2	Occupied Channel Bandwidth	± 4 kHz	± 8 kHz	3 dB Bandwidth
M1-INT: 2a	Minimum Receiver Bandwidth	± 10 kHz	± 8 kHz	3 dB Bandwidth
M1-INT: 3	Interrogator Transmit Maximum EIRP Power Limits within Communication Zone	65,5 dB μ A/m		@ d = 10m see ITUR 012E-WB9
M1-INT: 3	Interrogator Transmit Spurious Emissions	27 dB μ A/m		@9 kHz descending 3dB/octave, until 10 MHz

Ref.	Parameter	Description Type A	Description Type B	Options/Comments
M1-INT: 4a	Interrogator Transmit Spurious Emissions, In-Band (for Spread Spectrum systems)	Not appropriate for this MODE		
M1-INT: 4b	Interrogator Transmit Spurious Emissions, Out-of-Band	See M1A-F3		
M1-INT: 5	Interrogator Transmitter Spectrum Mask	Emissions below 135 kHz 65,5 dBμA/m @ f<135kHz	65,5 dBμA/m @ f<135kHz 50 dBμA/m @ f<135-140kHz 30 dBμA/m @ f<140-148,5kHz	
M1-INT: 6	Timing			
M1-INT: 6a	Transmit to Receive Turn Around Time	1,2 ms		Interrogator has to wait min. 1,2 ms before sending next command
M1-INT: 6b	Receive to Transmit Turn Around Time	2 ms		Interrogator has to wait min 2 ms for answer of tag before signaling a timeout error.
M1-INT: 6c	Dwell Time or Interrogator Transmit Power On Ramp	< 2 ms	< 2ms	
M1-INT: 6d	Decay Time or Interrogator Transmit Power Down Ramp	Not appropriate for this MODE		
M1-INT: 7	Modulation	OOK (100% ASK)		
M1-INT: 7a	Spreading Sequence (for Frequency Hopping [FHSS] systems)	Not appropriate for this MODE		
M1-INT: 7b	Chip Rate (for Spread Spectrum systems)	Not appropriate for this MODE		
M1-INT: 7c	Chip Rate Accuracy (for Spread Spectrum systems)	Not appropriate for this MODE		
M1-INT: 7d	Modulation Index	100%		
M1-INT: 7e	Duty Cycle	Not appropriate for this MODE		
M1-INT: 7f	FM Deviation	Not appropriate for this MODE		

Ref.	Parameter	Description Type A	Description Type B	Options/Comments
M1-INT: 8	Data Coding	Pulse interval encoding (PIE)		
M1-INT: 9	Bit Rate	Average 5,2 kbit/s	1 to 2,3 kbit/s (optional)	
M1-INT: 9a	Bit Rate Accuracy	Synchronous to the carrier frequency		
M1-INT: 10	Interrogator Transmit Modulation Accuracy	Not appropriate for this MODE		
M1-INT: 11	Preamble	No Preamble		
M1-INT: 11a	Preamble Length			
M1-INT: 11b	Preamble Waveform			
M1-INT: 11c	Bit Sync Sequence			
M1-INT: 11d	Frame Sync Sequence	Start Of Frame pattern (SOF)		
M1-INT: 11e	Postamble	none	End Of Frame pattern (EOF), 6 bits	
M1-INT: 12	Scrambling (for Spread Spectrum systems)	Not appropriate for this MODE		
M1-INT: 13	Bit Transmission Order	Least significant bit (LSB) first.		
M1-INT: 14	Wake-up process	The dialogue between the Interrogator and the RF tag (one or more RF tags may be present at the same time) is conducted through the following consecutive operations: - activation of the RF tag by the RF operating field of the interrogator, - RFID tag waits silently for a command from the interrogator, - transmission of a command by the interrogator, - transmission of a response by the RFID tag.		
M1-INT: 15	Polarization	Not Applicable (near field)		

5.3.2 Tag to interrogator link

Ref.	Parameter Name	Description Type A	Description Type B	Options/Comments
M1-TAG: 1	Operating Frequency Range Sub-carrier Frequencies	See M1-INT: 1 No subcarrier	See M1-INT: 1 134,2/123,7 $\pm$ 4 kHz using FSK technique	
M1-TAG: 1a	Default Operating Frequency	See M1-INT: 1a		
M1-TAG: 1b	Operating Channels (for Spread Spectrum systems)	Not appropriate for this MODE		
M1-TAG: 1c	Operating Frequency Accuracy	see M1-INT: 1c		
M1-TAG: 1d	Frequency Hop Rate (for Frequency Hopping [FHSS] systems)	Not appropriate for this MODE		
M1-TAG: 1e	Frequency Hop Sequence (for Frequency Hopping [FHSS] systems)	Not appropriate for this MODE		
M1-TAG: 2	Occupied Channel Bandwidth	$\pm$ 10 kHz	$\pm$ 15 kHz	
M1-TAG: 3	Transmit Maximum EIRP	Not appropriate for this MODE		
M1-TAG: 4	Transmit Spurious Emissions	Not appropriate for this MODE		
M1-TAG: 4a	Transmit Spurious Emissions, In-Band (for Spread Spectrum systems)	Not appropriate for this MODE		
M1-TAG: 4b	Transmit Spurious Emissions, Out-of-Band	Not appropriate for this MODE		
M1-TAG: 5	Transmit Spectrum Mask	Not appropriate for this MODE		
M1-TAG: 6a	Transmit to Receive Turn Around Time	see M1-INT: 6b		
M1-TAG: 6b	Receive to Transmit Turn Around Time	see M1-INT: 6a		
M1-TAG: 6c	Dwell Time or Transmit Power On Ramp	Not appropriate for this MODE		
M1-TAG: 6d	Decay Time or Transmit Power Down Ramp	Not appropriate for this MODE		

Ref.	Parameter Name	Description Type A	Description Type B	Options/Comments
M1-TAG: 7	Modulation (on the carrier)	The RF tag shall be capable to communicate with the interrogator via an inductive coupling area, whereby the carrier frequency is modulated by switching a load in the RF tag.	Not appropriate for this type	
M1-TAG: 7a	Spreading Sequence (for Frequency Hopping [FHSS] systems)	Not appropriate for this MODE		
M1-TAG: 7b	Chip Rate (for Spread Spectrum systems)	Not appropriate for this MODE		
M1-TAG: 7c	Chip Rate Accuracy (for Spread Spectrum systems)	Not appropriate for this MODE		
M1-TAG: 7d	On-Off Ratio	Not appropriate for this MODE		Load modulation
M1-TAG: 7e	Sub-carrier Frequency	Not appropriate for this MODE	134,2 /123,7 $\pm$ 4 kHz using FSK technique	
M1-TAG: 7f	Sub-carrier Frequency Accuracy Tolerance of Direct Generated tag to interrogator Link Carrier	Not appropriate for this MODE		
M1-TAG: 7g	Sub-Carrier Modulation	Not appropriate for this MODE		
M1-TAG: 7h	Duty Cycle	Not appropriate for this MODE		
M1-TAG: 7i	FM Deviation	Not appropriate for this MODE		
M1-TAG: 8	Data Coding	Manchester Code or Dual Pattern Code	NRZ	
M1-TAG: 9	Bit Rate	Manchester Code : 4 kbit/s ($f_{Ac}/32$) Dual Pattern Code: 2 kbit/s ($f_{Ac}/64$) during inventory	NRZ "0" : 8,2 kbit/s NRZ "1" : 7,7 kbit/s	
M1-TAG: 9a	Bit Rate Accuracy	Derived from the carrier		
M1-TAG: 10	Tag Transmit Modulation Accuracy (for Frequency Hopping [FHSS] systems)	Not applicable for this MODE		
M1-TAG: 11	Preamble	No Preamble		
M1-TAG: 11a	Preamble Length			

Ref.	Parameter Name	Description Type A	Description Type B	Options/Comments
M1-TAG: 11b	Preamble Waveform			
M1-TAG: 11c	Bit Sync Sequence	Start Of Frame pattern (SOF), 3 bits	Start Of Frame pattern (SOF), 6 bits End Of Frame pattern (EOF), 6 bits	
M1-TAG: 12	Scrambling (for Spread Spectrum systems)	Not appropriate for this MODE		
M1-TAG: 13	Bit Transmission Order	Least Significant bit (LSB) first		
M1-TAG: 14	Reserved			
M1-TAG: 15	Polarization	Not Applicable(Near Field)		
M1-TAG: 16	Minimum tag Receiver Bandwidth	± 10 kHz	± 15 kHz	

6 Transmission Protocol

6.1 Basic elements

The transmission protocol defines the mechanism to exchange instructions and data between the interrogator and the tags, in both directions. The interrogator shall be capable to communicate with tags of both Type A (FDX) and Type B (HDX).

It is based on the following concepts:

- "Interrogator Talks First". This means that any tag does not start transmitting, unless it has received and properly decoded an instruction sent by the interrogator.
- Tags are uniquely identified by a 64 bit Unique Identifier (UID). See clause 6.2.
- The protocol consists of an exchange of
 - a request from the interrogator to the tag
 - a response from the tag(s) to the interrogator
- The protocol is bit-oriented. The number of bits transmitted after a SOF depends on the respective request and response.

Flags are used for the control of request and response. The setting of the flags indicates either request and response variants (e.g. number of slots) or the presence of optional fields (e.g. AFI). When the flag is set to one (1), the field is present. When the flag is reset to zero (0), the field is absent.

RFU flags shall be set to zero (0).

6.2 Unique identifier

6.2.1 Unique identifier (UID)

The tags are uniquely identified by a 64 bit unique identifier (UID). The UID shall be set permanently by the IC manufacturer in accordance with Figure 13.