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FINAL COMMITTEE DRAFT

ISO/IEC 14443-3

Identification cards — Contactless integrated circuit(s) cards — Proximity cards —

Part 3: Initialization and anticollision

Cartes d'identification — Cartes à circuit(s) intégrés sans contacts — Cartes de Proximité — Partie 3: Initialisation et anticollision

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Contents

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 JTC1. 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.
International Standard ISO/IEC 14443-3 was prepared by Joint Technical Committee ISO/IEC JTC1/SC17, Information technology, Subcommittee SC17, *Identification cards and related devices.*

ISO/IEC 14443 consists of the following parts, under the general title *Identification cards* **-** *Contactless integrated circuit(s) cards* **-** *Proximity cards:*

- *Part 1: Physical characteristics*
- *Part 2: Radio frequency power and signal interface*
- *Part 3: Initialization and anticollision*
- *Part 4: Transmission protocols*

Annexes A, B, C and D of this part of ISO/IEC 14443 are for information only.

Introduction

ISO/IEC 14443 is one of a series of International Standards describing the parameters for identification cards as defined in ISO/IEC 7810, and the use of such cards for international interchange.

This part of ISO/IEC 14443 describes polling for PICCs entering the field of a PCD, the byte format and framing, the initial REQ and ATQ command content, methods to detect and communicate with one card among several cards (anticollision) and other parameters required to initialize communications between a proximity card and a proximity coupling device. Protocols and commands used by higher layers and by applications and which are used after the initial phase are described in ISO/IEC 14443-4.

ISO/IEC 14443 is intended to allow operation of proximity cards in the presence of other contactless cards conforming to ISO/IEC 10536 and ISO/IEC 15693.

Identification cards — Contactless integrated circuit(s) cards — Proximity cards —

Part 3:
Initialization and anticollision

1 Scope

This part of ISO/IEC 14443 describes:

- polling for PICCs entering the field of a PCD
- the byte format, the frames and timing used during the initial phase of communication between proximity coupling devices (PCDs) and proximity integrated circuit(s) cards (PICCs)
- the initial REQ and ATQ command content
- methods to detect and communicate with one card among several cards (anticollision)
- other parameters required to initialize communications between a proximity card and a proximity coupling device
- optional means to ease and speed up the selection of one among several cards based on application criteria i.e. the one it most likely has to transact with.

Protocols and commands used by higher layers and by applications and which are used after the initial phase will be described in ISO/IEC 14443-4.

This part of ISO/IEC 14443 is applicable to PICCs of Type A and of Type B (as described in ISO/IEC 14443-2).

2 Normative reference(s)

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/IEC 3309: 1993, *Information technology* - *Telecommunications and information exchange between systems* - *High-level data link control (HDLC) procedures* - *Frame structure*

ISO/IEC 7816-3: 1997, *Identification cards* - *Integrated circuit(s) cards with contacts* - *Part 3: Electronic signals and transmission protocols*

ISO/IEC 14443-2: *Identification cards* - *Contactless integrated circuit(s) cards* - *Proximity cards* - *Part 2: Radio frequency power and signal interface*

ITU-T Recommendation V.41

3 Term(s) and definition(s)

For the purposes of this International Standard, the terms and definitions given in ISO/IEC 14443-2, ISO/IEC 7816-3 and the following apply.

3.1
anticollision loop
Algorithm used to prepare for dialogue between PCD and one or more PICCs out of several in its energizing field.

3.2
bit collision detection protocol
Anticollision method employing collision detection at bit level within a frame. A collision occurs when at least two PICCs transmit complementary bit patterns (see ISO/IEC 14443-2 section 8.4.2) to the PCD. In this case the bit patterns are merged and the carrier is modulated with the subcarrier for the whole (100%) bit duration.
The PCD detects the collision bits and in cascading order recognizes all PICC IDs.

3.3
byte
A byte consist of 8 bits of data designated b1 to b8, from the most significant bit (MSB, b8) to the least significant bit (LSB, b1).

3.4
collision
Transmission by two PICCs in the same PCD energizing field and during the same time period, such that the PCD is unable to distinguish from which PICC the data originated.

3.5
elementary time unit (etu)
For this part of ISO/IEC 14443, one etu is defined as
1 etu = 128/fc (i.e. 9,4 µs nominal)

3.6
frame
A Frame is a series of data bits and optional error detection bits, with frame delimiters at start and end.

3.7
higher layer
Belonging to the application or higher layers of protocol that is not described in this part of ISO/IEC 14443.

3.8
time slot protocol
Method whereby a PCD establishes logical channels with one or more PICCs, which makes use of timeslot allocation for PICC response, similar to the slotted-Aloha method.

3.9
Unique identifier UID
UID is a number which is needed for the anticollision algorithm of type A

4 Symbols (and abbreviated terms)

For the purposes of this part of ISO/IEC 14443, the following abbreviations are used:

AFI	Application Familly Identifier. Card preselection criteria by application
APa	Anticollision Prefix a, used in ATQB
APc	Anticollision Prefix c, used in Attribute
APf	Anticollision Prefix f, used in REQB

APn	Anticollision Prefix n, used in Slot-MARKER Command
ATA	Answer To Attrib
ATQ	Answer To Request
ATQA	Answer To Request of Type A
ATQB	Answer To Request of Type B
ATTRIB	PICC selection command
BCC	UID CLn checkbyte, calculated as exclusive-or over the 4 previous bytes
CLn	Cascade level n, $3 \geq n \geq 1$
CT	Cascade Tag, ‘88’
CRC_A	Cyclic Redundancy Check error detection code defined in 6.1.10
CRC_B	Cycilc Redundancy Check error detection code defined in 7.2
DESEL	Deselect Command
E	End of communication, Type A
EGT	Extra Guard Time
EOF	End Of Frame, Type B
etu	elementary time unit. Duration of 1 bit of data transmission.
FGT	Frame Guard Time
fc	carrier frequency (13,56 MHz)
fs	subcarrier frequency
ID	IDentification number
INF	INFormation field belonging to higher layer
LSB	Least Significant Bit
MSB	Most Significant Bit
N	Number of anticollision slots or PICC response probability in each slot
n	Variable integer value as defined in the specific clause
NAD	Node ADdress
NVB	Number of Valid Bits
P	Odd parity bit
PARAM	Parameter in Attribute format
PCD	Proximity Coupling Device (Reader)
PICC	Proximity Card
PUPI	Pseudo-Unique PICC Identifier
R	Slot number chosen by the PICC during the anticollision sequence
REQA	Request Command, Type A
REQB	Request Command, Type B
RFU	Reserved for Future ISO/IEC Use
S	Start of communication, Type A
SAK	Select AcKnowledge
SEL	Select Command
SOF	Start Of Frame, Type B
TR0	Minimum delay of silence between PCD off and PICC on. (Type B only)
TR1	Minimum subcarrier on duration before PICC data transmission. (Type B only)
UID	Unique IDentification
UID*n*	Byte number *n* of unique identification, $n \geq 0$

For the purposes of this part of ISO/IEC 14443, the following notation applies:
$(xxxxx)_b$ Data bit representation
‘XY’ hexadecimal notation, equal to XY to the base 16

5 Polling

When a PICC is exposed to a non-modulated operating field (see ISO/IEC 14443-2) it shall be able to accept a request within 5 ms.

Example:

When a PICC type A receives any type B command it shall be able to accept a REQA within 5 ms.
When a PICC type B receives any type A command it shall be able to accept a REQB within 5 ms.

In order to detect PICCs which enter its energizing field, a PCD sends repeated Request commands and looks for an ATQ. The Request commands shall use REQA and REQB described herein in any sequence and in addition may use other coding(s) described in Annex C. This process is designated “Polling”.

6 Type A – Initialization and anticollision

This section describes the bit collision detection protocol applicable for PICCs of type A.

6.1 Byte, frame and command format and timing

This section defines the byte, frame and command formats and timing used during communication initialization and anticollision. For bit representation and coding refer to ISO/IEC 14443-2.

6.1.1 Frame delay time

The frame delay time FDT is defined as the time between two frames transmitted in opposite directions.

6.1.2 Frame guard time

The frame guard time FGT is defined as the minumum frame delay time.

6.1.3 Frame delay time PCD to PICC

This is the time between the end of the last pause transmitted by the PCD and the first modulation edge within the startbit transmitted by the PICC and shall respect the timing defined in figure 6.1, where *n* is an integer value.

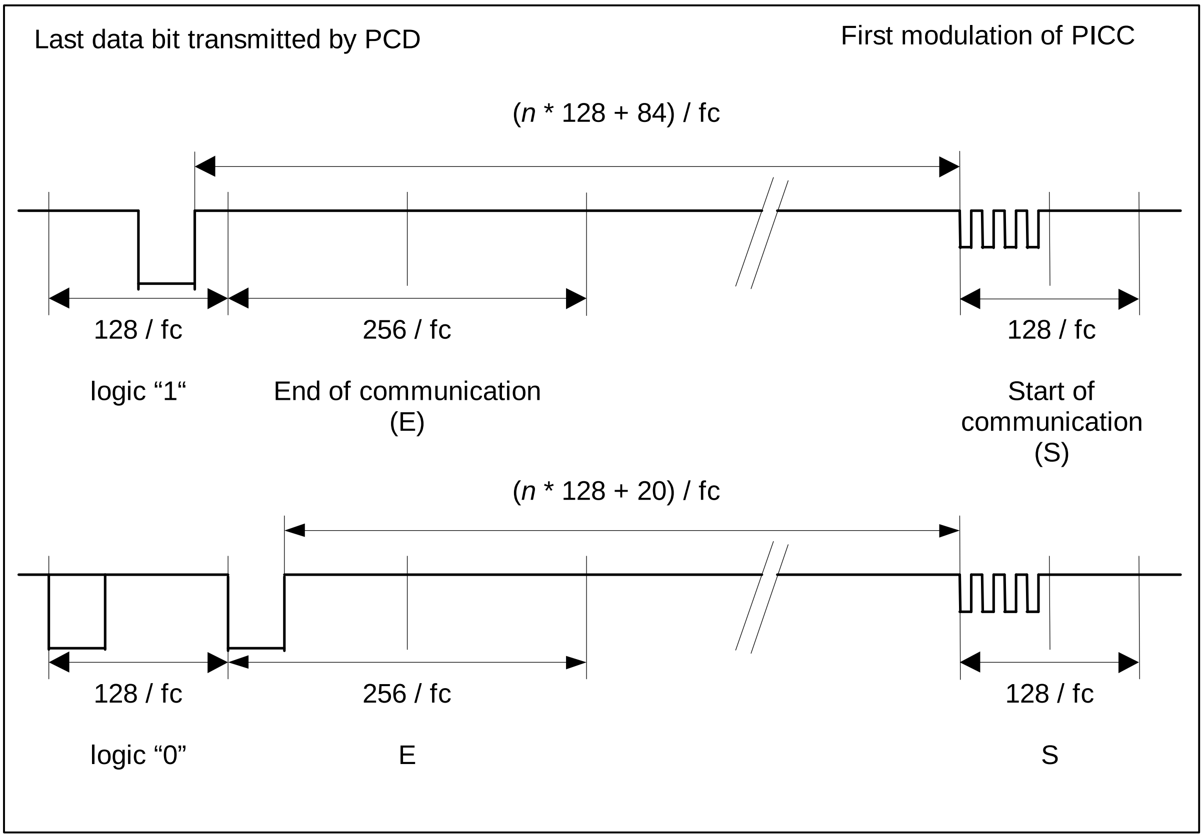

Figure 6.1 - Frame delay time PICC to PCD

Table 6.1 defines values for *n* and FDT depending on the command type and the logic state of the last transmitted data bit in this command.

Command type	n (integer value)	FDT	
		last bit = (1)b	last bit = (0)b
REQA Command WAKE-UP Command ANTICOLLISION Command SELECT Command	9	1236 / fc	1172 / fc
All other commands	≥ 9	(n * 128 + 84) / fc	(n * 128 + 20) / fc

Table 6.1 - Frame delay time PICC to PCD

Note: The value n = 9 means that all PICCs in the field shall respond in a synchronous way which is needed for anticollision.
For all other commands the PICC shall ensure that the first modulation edge within the startbit is aligned to the bit-grid defined in figure 6.1.

6.1.4 Frame delay time PICC to PCD

This is the time between the last modulation transmitted by the PICC and the first pause transmitted by the PCD and shall be at least 1172 / fc.

6.1.5 Request Guard Time

The Request Guard Time is defined as the minimum time between the start bits of two consecutive Request commands. It has the value 7000/fc.

6.1.6 Frame formats

The following frame types are defined for the bit collision detection protocol.

6.1.7 REQA and WAKE-UP frames

Request and wake-up frames are used to initiate communication and consist of, in the following order:

- Start of communication
- 7 data bits transmitted LSB first. (The data content is ‘26’ for a standard REQA and ‘52’ for a WAKE-UP Request).
- End of communication

No parity bit is added.

	LSB						MSB	
S	0	1	1	0	0	1	0	E

‘26’

First bit transmitted

Figure 6.2 – REQA Frame

6.1.8 Standard frame

Standard frames are used for data exchange and consist of

- Start of communication
- n * (8 data bits + odd parity bit). with n ≥ 1. The LSB of each data byte is transmitted first. Each data byte is followed by an odd parity bit.
- End of communication

n*(8 data bits + odd parity bit)

	LSB																				
S	b1	b2	b3	b4	b5	b6	b7	b8	P	b1	b2	b3	b6	b7	b8	P	b1	b8	P	E

1st data byte

2nd data byte

nth byte

1st bit transmitted

parity

End of communication

Figure 6.3 – Standard Frame

6.1.9 Bit oriented anticollision frame

A collision is detected when at least two PICCs transmit different bit patterns to the PCD. In this case the carrier is modulated with the subcarrier for the whole bit duration for at least one bit.

Bit oriented anticollision frames are only used during bit frame anticollision loops and are in fact standard frames with a length of 7 data bytes, split into two parts: part 1 for transmission from PCD to PICC and part 2 for transmission from PICC to PCD.

For the length of part 1 and part 2, the following rules shall apply:
Rule 1: The sum of data bits shall be 56
Rule 2: The minimum length of part 1 shall be 16 data bits
Rule 3: The maximum length of part 1 shall be 55 data bits
Consequently, the minimum length of part 2 shall be 1 data bit and the maximum length shall be 40 data bits.
Since the split can occur at any bit position within a data byte, two cases are defined:
Case FULL BYTE: Split after a complete data byte. A parity bit is added after the last data bit of part 1.
Case SPLIT BYTE: Split within a data byte. No parity bit is added after the last data bit of part1.

The following examples for case FULL BYTE and case SPLIT BYTE define the bit organization and order of bit transmission.

Note: These examples include proper values for NVB and BCC.

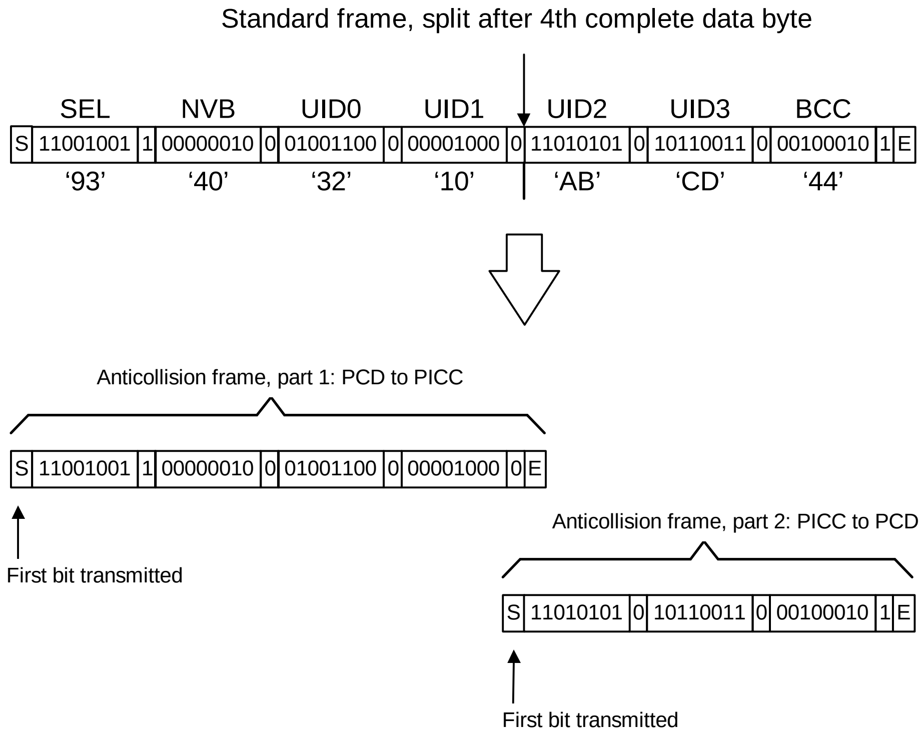

Figure 6.4 – Bit organization and transmission of bit oriented anticollision frame, case FULL BYTE

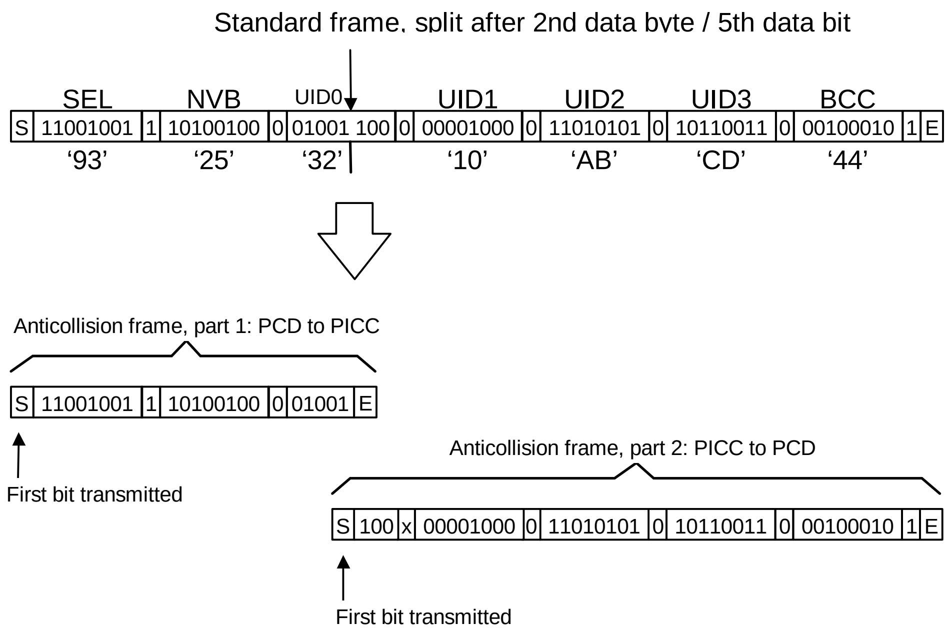

Figure 6.5 – Bit organization and transmission of bit oriented anticollision frame, case SPLIT BYTE

For a SPLIT BYTE, the first parity bit of part 2 shall be ignored by the PCD.

6.1.10 CRC_A

The CRC_A encoding and checking process is defined in ITU-T Recommendation V.41, paragraph 2. The generator polynomial used to generate the check bits is $x^{16} + x^{12} + x^5 + 1$. The initial value shall be ‘6363’. The CRC_A shall be appended to the data bytes and shall be transmitted via standard frames.

Note: An other description can be derived from ISO/IEC 3309 with considering the following modifications:
- initial value: ‘6363’ instead of ‘FFFF’
- register content shall not be inverted after calculation.

For an example refer to Annex B.

6.2 PICC states

The following sections provide descriptions of the states for a PICC of type A specific to the bit collision detection protocol.

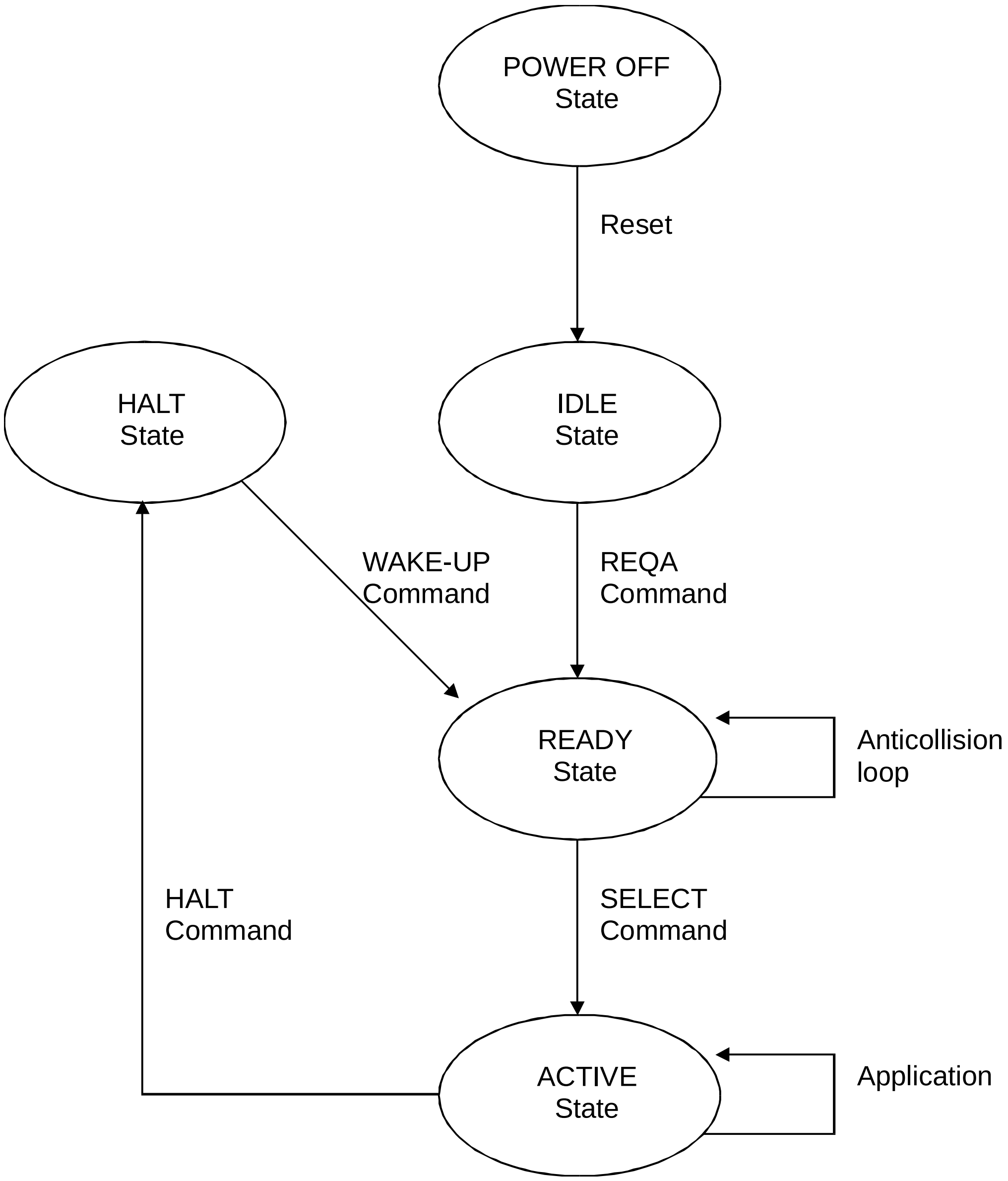

Figure 6.6 – PICC Type A state diagram (informative)

Note: A more detailed PICC Type A state diagram is available in Annex D.

6.2.1 POWER-OFF state

In the POWER-OFF state, the PICC is not energized due to lack of carrier energy and shall not emit subcarrier.

6.2.2 IDLE state

After the field has been active for a maximum delay defined in clause 5, the PICC shall enter its IDLE state. In this state, the PICC is powered on, and is capable of demodulating and recognizing valid REQA and WAKE-UP Commands from the PCD.

6.2.3 READY state

This state is entered as soon as a valid REQA or WAKE-UP message has been received and exited when the PICC is selected with its UID. In this state either the bit frame anticollision or other optional anticollision method can be applied. Cascade levels are handled inside this state to get all UID CLn.

6.2.4 ACTIVE state

This state is entered by selecting the PICC with its complete UID.

6.2.5 HALT state

This state is entered by either the HALT Command defined in 6.3.4 or by an application specific command not defined in this part of ISO/IEC 14443. In this state a PICC shall respond only to a WAKE-UP Command, which transits the PICC to its READY State.

Note: PICCs that are in HALT State will not participate in any further communication unless a WAKE-UP Command is applied.

6.3 Command set

The commands used by the PCD to manage communication with several PICCs are:

- REQA
- WAKE-UP
- ANTICOLLISION
- SELECT
- HALT

The commands use the byte and frame formats described above.

6.3.1 REQA Command

The REQA Command is sent by the PCD to probe the field for PICCs of Type A

6.3.2 WAKE-UP Command

The WAKE-UP Command is sent by the PCD to put PICCs which have entered the HALT State back into the READY State. They shall then participate in further anticollision and selection procedures.

Table 6.2 shows the coding of REQA and WAKE-UP Commands which use the Request frame format.

Table 6.2 - Coding of Request Frame

b7	b6	b5	b4	b3	b2	b1	Meaning
0	1	0	0	1	1	0	‘26’ = REQA
1	0	1	0	0	1	0	‘52’ = WAKE-UP
0	1	1	0	1	0	1	‘35’ = Optional time slot method, see Annex C
1	0	0	x	x	x	x	‘40’ to ‘4F’ = Proprietary
1	1	1	1	x	x	x	‘78’ to ‘7F’ = Proprietary
all other							RFU

6.3.3 ANTICOLLISION Command, SELECT Command

These commands are used during an anticollision loop. The ANTICOLLISION and SELECT Commands consist of:

- Select code SEL (1 byte)
- Number of valid bits NVB (1 byte)
- 0 to 40 data bits of UID CLn according to the value of NVB

SEL specifies the cascade level CL*n*.
NVB specifies the number of valid bits of UID CLn transmitted by the PCD.

Note: As long as NVB does not specify 40 valid bits, the command is called ANTICOLLISION Command, where the PICC remains in READY State.

If NVB specifies 40 data bits of UID CLn (NVB='70'), a CRC_A shall be appended. This command is called SELECT Command. If the PICC has transmitted the complete UID, it transits from READY State to ACTIVE State and indicates in its SAK-response that UID is complete. Otherwise, the PICC remains in READY state and the PCD shall initiate a new anticollision loop with increased cascade level.

6.3.4 HALT Command

The HALT Command consists of four bytes and shall be transmitted using the Standard Frame.

First bit transmitted

↓

S	‘50’	‘00’	CRC_A	E

Figure 6.7 – HALT Command frame

If the PICC responds with any modulation during a period of 1 ms after the end of the HALT Frame, this response shall be interpreted as 'not acknowledge'.

6.4 Select sequence

The purpose of the select sequence is to get the UID from one PICC and to select this PICC for further communication.

6.4.1 Select sequence flowchart

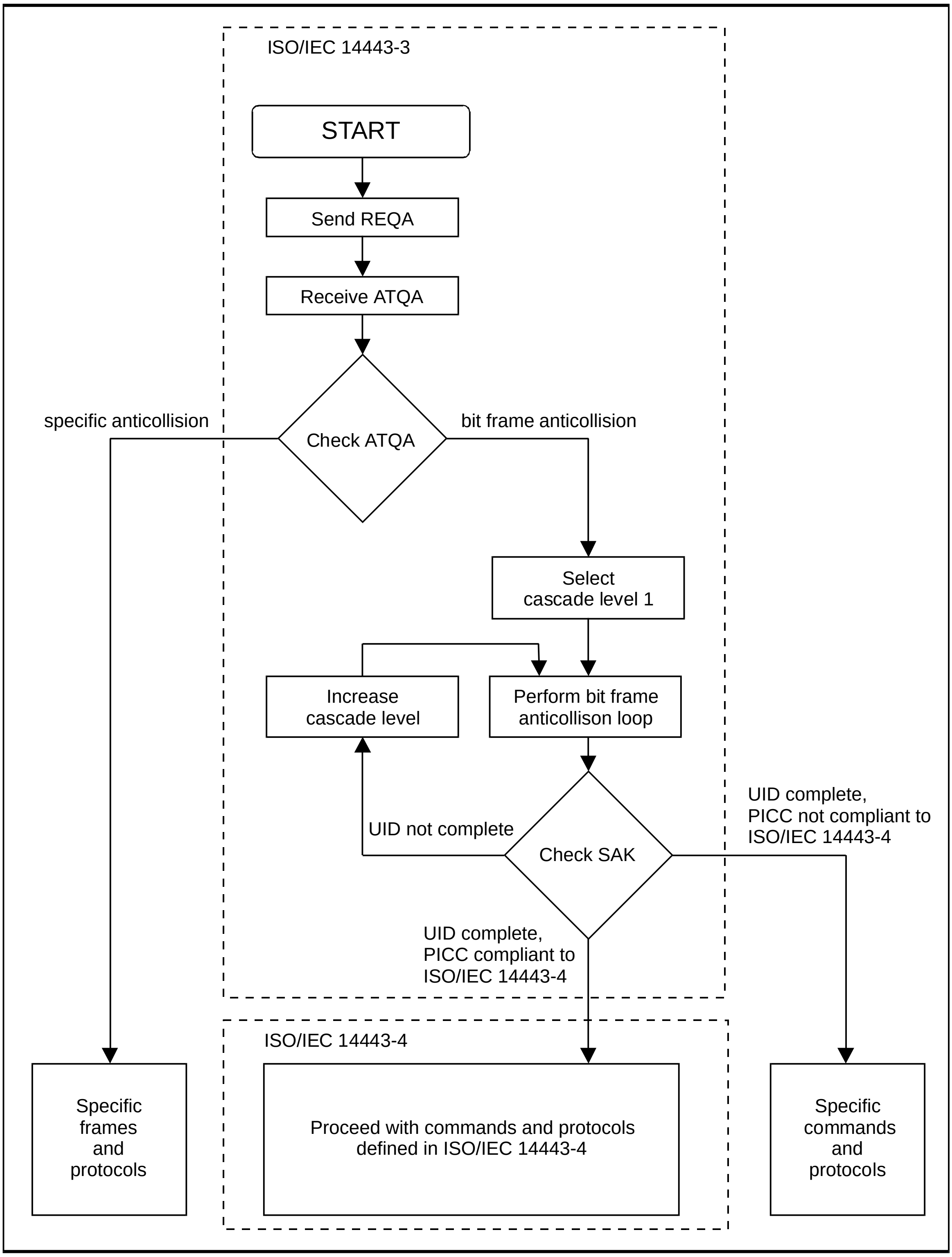

Figure 6.8 – Initialization and anticollision flow-chart for PCD

6.4.2 ATQA - Answer To Request

After the Request command (REQA) is transmitted by the PCD, all PICCs respond synchronously with their Answer to Request (ATQA), which codes the applicable anticollision type in two data bytes.

If there are multiple PICC answers, collisions may occur. The PCD shall decode a collision inside ATQA as a $(1)_b$. This results in a logical OR of all ATQAs.

An example is given in Annex D.

6.4.2.1 Coding of ATQA

Table 6.3 - Coding of ATQA

MSB LSB

b16	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1
RFU								UID size bit frame		RFU	Bit frame anticollision				

6.4.2.2 Coding rules for bit frame anticollision

Rule 1 Bits b7 and b8 code the UID size (single, double or triple).
Rule 2 One out of the five bits b1, b2, b3, b4 or b5 shall be set to $(1)_b$ to indicate bit frame anticollision

Table 6.4 - Coding of b7, b8 for bit frame anticollision

b8	b7	Meaning
0	0	UID size: single
0	1	UID size: double
1	0	UID size: triple
1	1	RFU

Table 6.5 - Coding of b1 - b5 for bit frame anticollision

b5	b4	b3	b2	b1	Meaning
1	0	0	0	0	bit frame anticollision
0	1	0	0	0	bit frame anticollision
0	0	1	0	0	bit frame anticollision
0	0	0	1	0	bit frame anticollision
0	0	0	0	1	bit frame anticollision
All other values					RFU

6.4.3 Anticollision and Select

6.4.3.1 Anticollision loop within each cascade level

The following algorithm shall apply to the anticollision loop:

Step 1: The PCD assigns SEL with the code for the selected anticollision type and cascade level.

Step 2: The PCD assigns NVB with the value of ‘20’.
Note: This value defines that the PCD will transmit no part of UID CLn. Consequently this command forces all PICCs in the field to respond with their complete UID CLn.

Step 3: The PCD transmits SEL and NVB.

Step 4: All PICCs in the field shall respond with their complete UID CLn.

Step 5: Assuming the PICCs in the field have unique serial numbers, then if more than one PICC responds, a collision occurs. If no collision occurs, steps 6 to 10 are skipped.

Step 6: The PCD shall recognize the position of the first collision.

Step 7: The PCD assigns NVB with a value that specifies the number of valid bits of UID CLn. The valid bits shall be part of the UID CLn that was received before a collision occurred added by a (0)b or (1)b, decided by the PCD. A typical implementation adds a (1)b.

Step 8: The PCD transmits SEL and NVB, followed by the valid bits itself.

Step 9: Only PICCs of which the part of UID CLn is equal to the valid bits transmitted by the PCD shall transmit their remaining bits of the UID CLn.

Step 10: If further collisions occur, steps 6 to 9 will be repeated. The maximum number of loops will be 32.

Step 11: If no further collision occurs, the PCD assigns NVB with the value of ‘70’.
Note: This value defines that the PCD will transmit the complete UID CLn.

Step 12: The PCD transmits SEL and NVB, followed by all 40 bits of UID CLn, followed by CRC_A checksum.

Step 13: The PICC which UID CLn matches the 40 bits responds with its SAK.

Step 14: If the UID is complete, the PICC shall transmit SAK with cleared cascade bit and transit from READY State to ACTIVE State.

Step 15: The PCD shall check if the cascade bit of SAK is set to decide whether further anticollision loops with increased cascade level shall follow.

If the UID of a PICC is well known, the PCD may skip step 2 **-** step 10 to select this PICC without performing the anticollision loop.

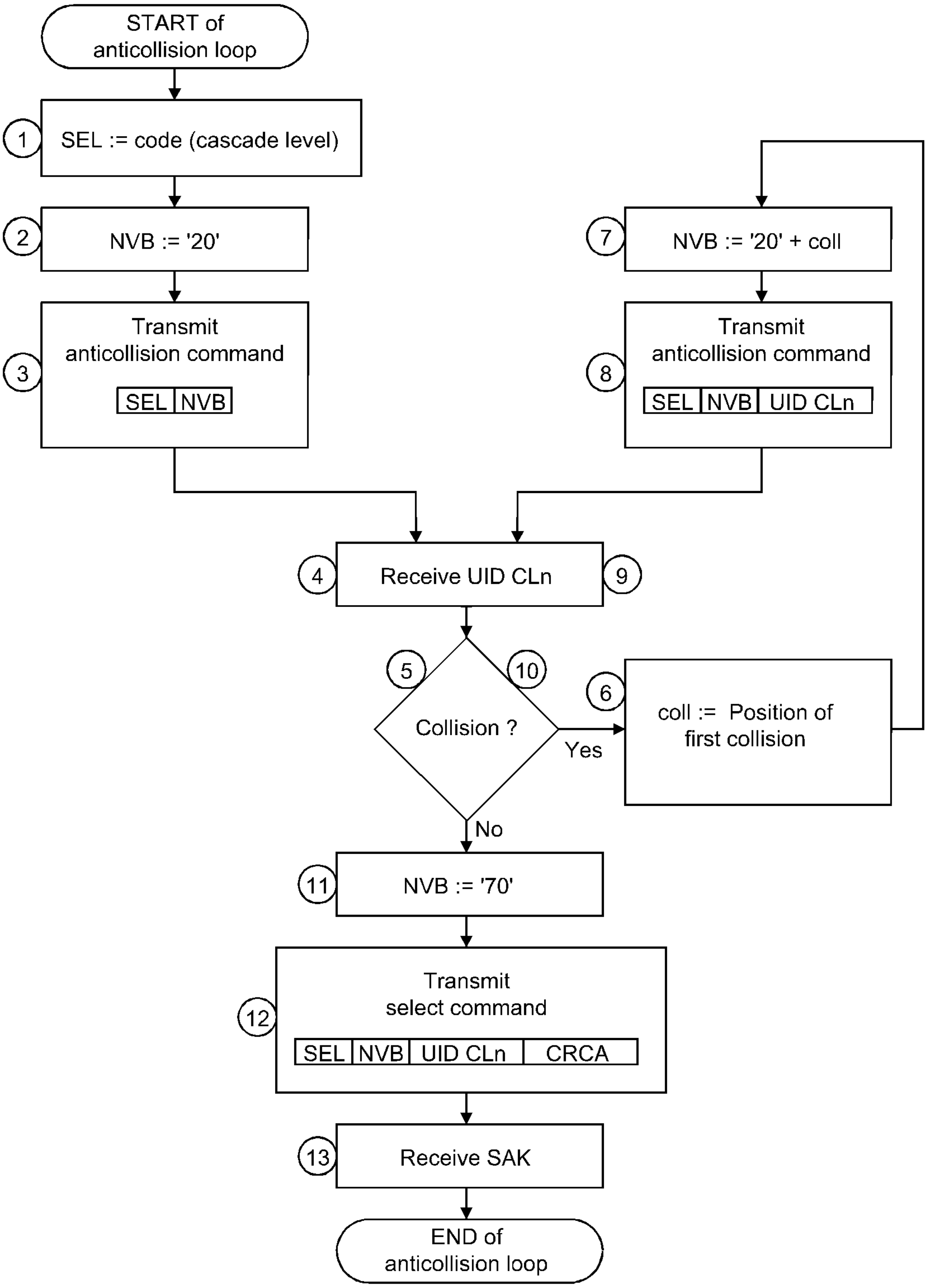

Figure 6.9 - Anticollision loop, flow chart for PCD

Note: The circled numbers correspond to the steps of the algorithm.

6.4.3.2 Coding of SEL (Select code)

Length: 1 byte
Possible values: ‘93’, ‘95’, ‘97’

Table 6.6 - Coding of SEL

b8	b7	b6	b5	b4	b3	b2	b1	Meaning
1	0	0	1	0	0	1	1	‘93’: Select cascade level 1
1	0	0	1	0	1	0	1	‘95’: Select cascade level 2
1	0	0	1	0	1	1	1	‘97’: Select cascade level 3
1	0	0	1	other values				RFU

6.4.3.3 Coding of NVB (Number of Valid Bits)

Length: 1 byte

The upper 4 bits are called bytecount and specify the number of all valid data bits divided by 8 including SEL and NVB transmitted by the PCD. Consequently, the minimum value of bytecount is 2 and the maximum value is 7.

The lower 4 bits are called bitcount and specify the number of all valid data bits modulo 8 transmitted by the PCD.

Table 6.7 - Coding of NVB

b8	b7	b6	b5	Meaning
0	0	1	0	bytecount = 2
0	0	1	1	bytecount = 3
0	1	0	0	bytecount = 4
0	1	0	1	bytecount = 5
0	1	1	0	bytecount = 6
0	1	1	1	bytecount = 7

b4	b3	b2	b1	Meaning
0	0	0	0	bitcount = 0
0	0	0	1	bitcount = 1
0	0	1	0	bitcount = 2
0	0	1	1	bitcount = 3
0	1	0	0	bitcount = 4
0	1	0	1	bitcount = 5
0	1	1	0	bitcount = 6
0	1	1	1	bitcount = 7

6.4.3.4 Coding of SAK (Select acknowledge)

SAK is transmitted by the PICC when NVB has specified 40 valid data bits and when all these data bits match with UID CLn.

SAK is transmitted via Standard frames, followed by CRC_A.

SAK	CRC_A
1 byte	2 bytes

Figure 6.10 - Select acknowledge (SAK)

The PCD shall check bit b3 to decide if UID is complete. The coding of bits b3 and b6 is given in Table 6.8.

Table 6.8 - Coding of SAK

b8	b7	b6	b5	b4	b3	b2	b1	Meaning
x	x	x	x	x	1	x	x	Cascade bit set: UID not complete
x	x	1	x	x	0	x	x	UID complete, PICC compliant with ISO/IEC 14443-4

x	x	0	x	x	0	x	x	UID complete, PICC not compliant with ISO/IEC 14443-4

If UID is not complete, the PICC shall remain in READY State and the PCD shall initiate a new anticollision loop with increased cascade level.

If the UID is complete, the PICC shall transmit SAK with cleared cascade bit and transit from READY State to ACTIVE State. The PICC shall set bit b6 of SAK when additional information is available.

The definition of the additional information is not subject of this part of the standard and will be defined in ISO/IEC 14443-4.

6.4.4 UID contents and cascade levels

The UID consists of 4, 7 or 10 UID bytes. Consequently, the PICC shall handle up to 3 cascade levels to get all UID bytes. Within each cascade level, a part of UID consisting of 5 data bytes shall be transmitted to the PCD. According to the maximum cascade level, three types of UID size are defined. This UID size has to be consistent with table 6.4.

Table 6.9 - UID size

Maximum cascade level	UID size	Number of UID bytes
1	single	4
2	double	7
3	triple	10

For the contents of UID, the following definitions apply:
UID CLn Part of UID according to cascade level *n*, consists of 5 bytes, $3 \geq n \geq 1$
UID*n* Byte #*n* of UID, $n \geq 0$
BCC UID CLn checkbyte, calculated as exclusive-or over the 4 previous bytes
CT Cascade tag, ‘88’

The UID is a fixed unique number or a random number which is dynamically generated by the PICC. The first byte (uid0) of the UID assigns the content of the following bytes of the UID.

<u>Single size UIDs</u>

uid0	Description
'08'	uid1 to uid3 is a random number which is dynamically generated
'x0' - 'x7' 'x9' - 'xE'	proprietary fixed number
'18' - 'F8' 'xF'	RFU

The value '88' of the cascade tag CT shall not be used for uid0 in single size UID.

<u>Double and triple size UIDs</u>

uid0	Description
Manufacturer ID according to ISO/IEC 7816-6/AM1	Each manufacturer is responsible for the uniqueness of the value of the other bytes of the unique number.

The values '81' to 'FE', which are marked for 'Private use' in ISO/IEC 7816-6/AM1 shall not be allowed in this context.

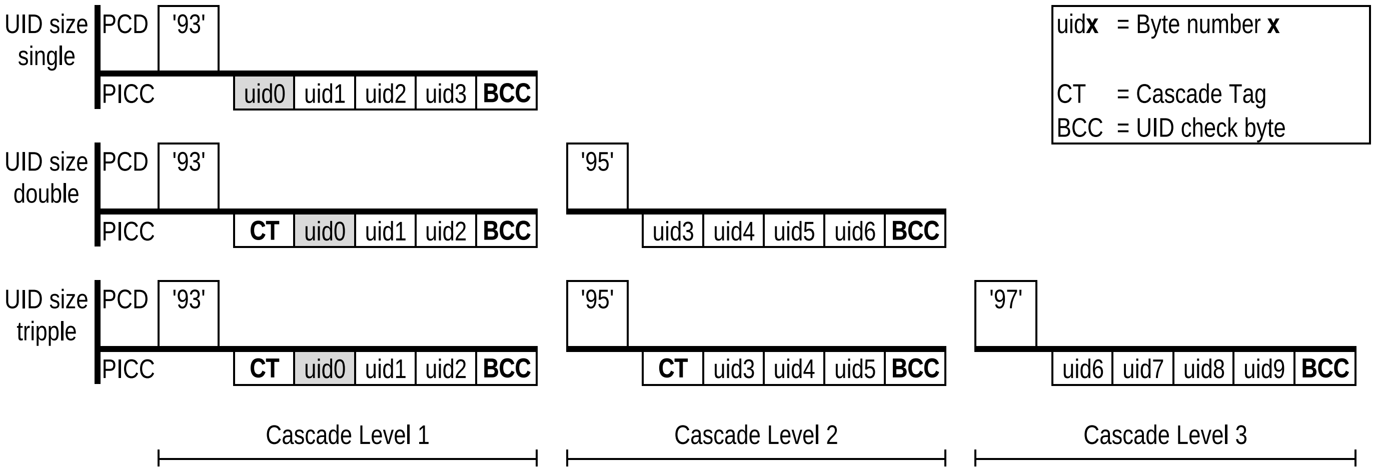

Figure 6.11 - Usage of cascade levels

Note: The purpose of the cascade tag is to force a collision with PICCs that have a smaller UID size. Consequently, neither UID0 nor UID3 shall have the value of the cascade tag.

The following algorithm shall apply to the PCD to get the complete UID:

Step 1: The PCD selects cascade level 1

Step 2: The anticollison loop shall be performed

Step 3: The PCD shall check the cascade bit of SAK

Step 4: If the cascade bit is set, the PCD shall increase the cascade level and initiate a new anticollision loop

Step 5: When a PICC is selected with its complete UID it shall transmit SAK with a cleared cascade bit and transit from the READY State to the ACTIVE State.

7 Type B – Initialization and anticollision

7.1 Bit, byte, and frame timing

This section defines the byte, frame and command timing used during communication initialization and anticollision for PICCs of Type B. For bit representation and coding refer to ISO/IEC 14443-2.

7.1.1 Character transmission format

Data bytes are transmitted and received between PICCs and a PCD by characters, the format of which during the Anti-collision sequence is as follows:

- One start bit at Low
- 8 data bits transmitted, LSB first
- 1 stop bit at High

The transmission of one byte is performed with a character requiring 10 etu as illustrated below

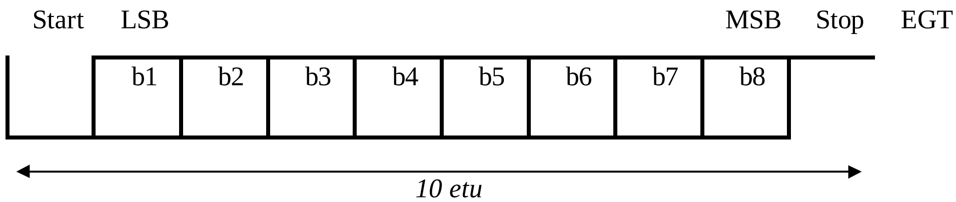

Figure 7.1 – Character format

Bit boundaries within a character shall occur between (n - 0,125) etu and (n + 0,125) etu where n is the number of bit boundaries after the start bit falling edge (1<=n<=9).

7.1.2 Character spacing

A character is separated from the next sent one by the extra guard time EGT.
The EGT between 2 consecutive characters sent by the PCD to the PICC shall be any value between 0 and 57 µs.
The EGT between 2 consecutive characters sent by the PICC to the PCD shall have any value between 0 and 19 µs.

7.1.3 Frame delimiters

PCD and PICC send characters as frames. The frame is normally delimited by SOF (Start Of Frame) and by EOF (End Of Frame). See 7.10.2 for exceptions.

SOF	Characters	EOF

Figure 7.2 – Frame Format

7.1.4 SOF

SOF is composed of

- one falling edge,
- followed by 10 etu with a logical 0,
- followed by one single rising edge located anywhere within the following etu,
- followed by at least 2 etu (but no more than 3 etu) with a logical 1.

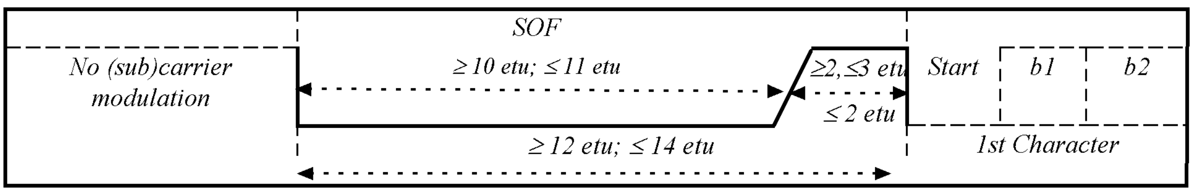

Figure 7.3 – SOF

7.1.5 EOF

EOF is composed of

- one falling edge,
- followed by 10 etu with a logical 0,
- followed by one single rising edge located anywhere within the following etu,

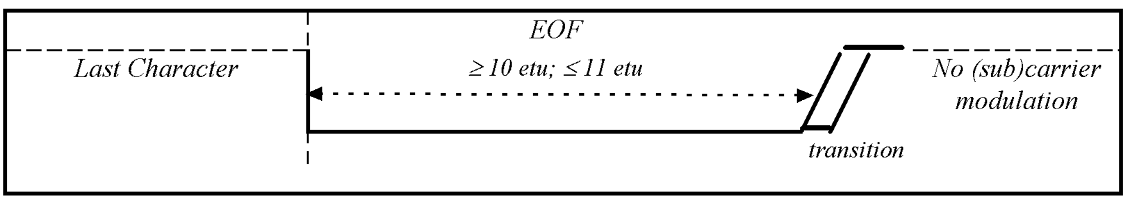

Figure 7.4 – EOF

Note: The probability of receiving a false EOF is low and corresponds to the transmission of a '00' character with a wrong reception of the stop bit.

7.1.6 PICC to PCD subcarrier and SOF

PICC start of communication after a PCD data transmission shall respect the timing defined in figure 7.4.
Minimum delays TR0 (between PCD EOF and PICC subcarrier on) and TR1 (between PICC subcarrier on and first bit transmission) can be defined at the start of an anticollision session (see coding of ATTRIB Command). The minimum values of TR0 and TR1 are defined in ISO/IEC 14443-2. The maximum value of TR1 is 200/fs. The maximum value of TR0 is defined in clause 7.10.

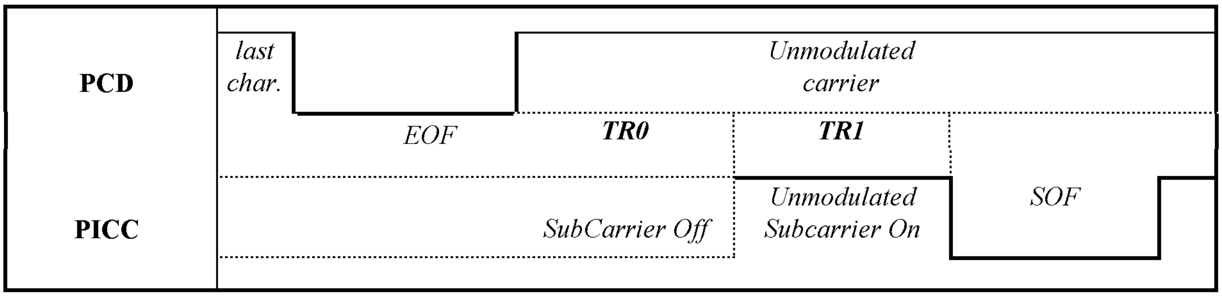

Figure 7.5 – PICC subcarrier SOF

A PICC may turn on the subcarrier only if it intends to begin transmitting information.

7.1.7 PICC to PCD subcarrier and EOF

PCD start of communication after a PICC data transmission and EOF shall respect the timing in figure 7.5.
The PICC shall turn off its subcarrier after the transmission of the EOF. The subcarrier signal shall

- not be stopped before the end of the EOF
- be stopped no later than 2 etu after the end of the EOF.

The minimum delay between the PICC EOF start (falling edge) and the PCD SOF start (falling edge) is 14 etu.

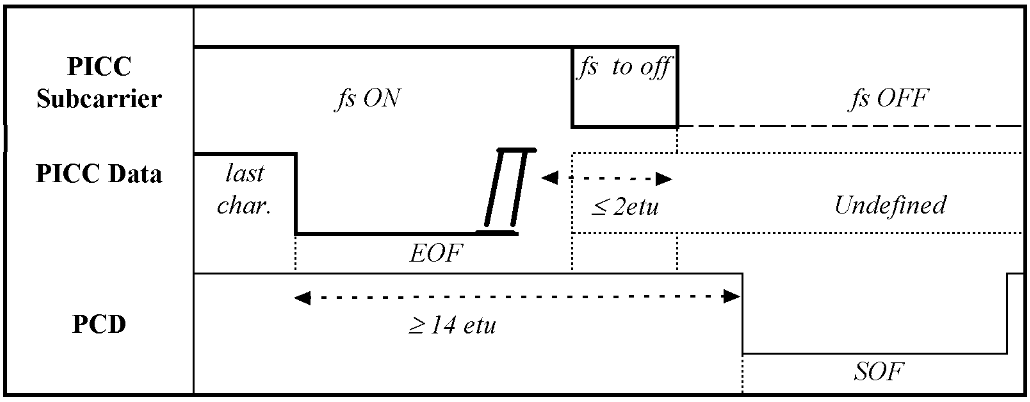

Figure 7.6 – PICC to PCD EOF

7.2 CRC_B

Data bytes (n Bytes)	**CRC_B** (2 Bytes)

Figure 7.7 – Position of a CRC_B within a frame

A frame shall only be considered correct if it is received with a valid CRC_B value.

The frame CRC_B is a function of k data bits, which consist of all the data bits in the frame, excluding start bits, stop bits, delays between bytes, SOF and EOF, and the CRC_B itself. Since data is encoded in bytes, the number of bits k is a multiple of 8.

For error checking, the two CRC_B bytes are included in the frame, after the data bytes and before the EOF. The CRC_B is as defined in ISO/IEC 3309. The initial register content shall be all ones: 'FFFF'. These two CRC_B bytes occur after the k/8 data bytes and before the EOF.

For example refer to Annex B.

7.3 Anticollision sequence

An anticollision sequence is managed by the PCD through a set of commands detailed in this section.

The PCD is the master of the communication with one or multiple PICCs. It initiates card communication activity by issuing a REQB command to prompt for PICCs to respond.

During the anticollision sequence it may happen that two or more PICCs respond simultaneously: this is a collision. The command set allows the PCD to handle sequences to separate PICC transmissions in time.

Having completed the anticollision sequence, PICC communication will fully be under control of the PCD, allowing only one PICC to talk at a time.

The Anticollision scheme is based on definition of time slots in which PICCs are invited to answer with minimum identification data. The number of slots is parametrized and can vary from 1 to some integer number. PICC response probability in each time slot is also controllable. PICCs are allowed to answer only once in the anticollision sequence. Consequently, even in case of multiple PICCs present in the PCD field, there will probably be a slot in which only one PICC answers and where the PCD is able to capture the identification data. Based on the identification data the PCD is able to establish a communication channel with the identified PICC.

An anticollision sequence allows selection of one or more PICCs for further communication at any time.

The set of commands allows implementation of different anticollision management strategies at the PCD level. This strategy is under the control of the application designer and can include:

- probabilistic (repetitive single slot prompt with response probability less than or equal to 1),
- pseudo-deterministic (multiple slots with scanning of all of them to have during the anticollision sequence the maximum probability that all present PICCs answer)
- any combination of these methods that can be conducted dynamically.

7.4 PICC states description

The PICC detailed behaviour during the anticollision sequence is defined by different states and transition conditions between states.

7.4.1 State transition diagram

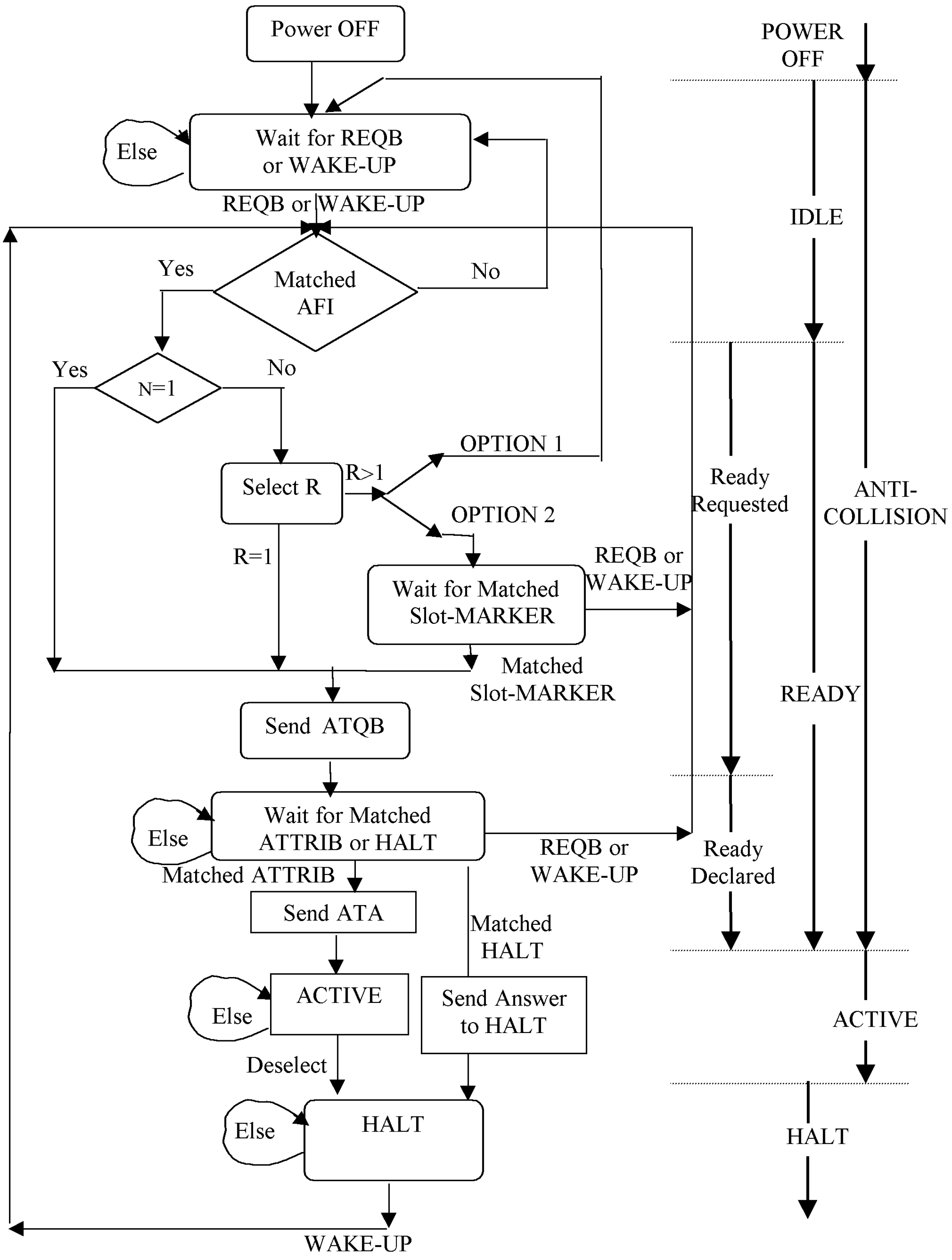

Figure 7.8 – PICC state transition flow chart example (informative)

Note 1: R is a number chosen by the PICC in the range from 1 to N (for coding of N see 7.7.4).
Note 2: Option 1 – For PICCs not supporting Slot-MARKER command (Probabilistic approach).
Option 2 – For PICCs supporting Slot-MARKER command (Time Slot approach).

7.4.2 General statement for state description and transitions

To any state apply the following exit conditions and transitions:

- The PICC returns to POWER_OFF State if the RF field disappears.

To any state specific to the anticollision sequence (except ACTIVE state) the following remarks apply:

- Default communication parameters as defined in the previous section are used.
- The PICC shall not emit subcarrier except to transmit response frames as specified in the previous sections.
- When a PICC is powered on and properly reset it listens to any command frame received from the PCD.
- If a frame from the PCD is valid (correct CRC_B), the PICC performs the required action and/or response depending on its state. Note that in anticollision commands the first 3 bits of the data in a frame are (101)b (3 first bits of Anticollision Prefix Byte).
- A PICC does not answer to any command frame not starting with (101)b (3 first bits of Anticollision Prefix Byte).
- PICCs only react to valid frames received (no response sent when transmission errors are detected).

7.4.3 POWER-OFF state

Description:
In the POWER_OFF state, the PICC is not powered due to lack of carrier energy.

State exit conditions and transitions:
If the PICC is in an energizing magnetic field greater than Hmin (see ISO/IEC 14443-2), it shall enter its IDLE state within a delay not greater than t_{ORB}.

7.4.4 IDLE state

Description:
In the IDLE state, the PICC is powered. It listens for frames and shall recognize REQB messages.

State exit conditions and transitions:
On reception of a valid REQB command frame the PICC defines a unique slot that will be used to send its ATQB, if any. (Valid request means valid frame with REQB command and correct AFI. See REQB command specificaton).

If the defined slot is the first slot the PICC shall transmit an ATQB response frame.

The PICC enters the READY-DECLARED State as soon as its ATQB has been sent.

If the defined slot is not the first slot, the PICC enters the READY-REQUESTED State.

7.4.5 READY-REQUESTED substate

Description:
In the READY-REQUESTED State, the PICC is powered and has defined the unique slot it will use to send its ATQB, if any.
It listens for frames and shall recognize REQB and Slot-MARKER messages.

State exit conditions and transitions:
On reception of a valid Slot-MARKER frame, the PICC shall answer an ATQB if its defined slot matches the slot marker. The answer probability in a particular slot shall not be higher than 1/N (N being the parameter of the last REQB received).

The PICC shall enter the READY-DECLARED state as soon as its ATQB has been sent.

If its defined slot does not match the slot marker, the PICC remains in the READY-REQUESTED state.

On reception of a valid REQB command frame the same conditions and transitions apply as on reception of a valid REQB command frame in the IDLE state.

7.4.6 READY-DECLARED substate

Description:
In the READY-DECLARED state, the PICC is powered and has sent its ATQB corresponding to the last valid REQB message received.

It listens to frames and shall recognize REQ, ATTRIB and HALT messages.

State exit conditions and transitions:
On reception of a valid frame with an ATTRIB Command the PICC shall enter the ACTIVE state if and only if the PUPI in the ATTRIB Command matches the PICC's PUPI.

If the PUPI in the ATTRIB Command does not match the PICC's PUPI the PICC remains in the READY-DECLARED state.

On reception of a valid REQB command frame the same conditions and transitions apply as on reception of a valid REQB command frame in the IDLE state.

On reception of a matched HALT Command the PICC shall enter the HALT state.

7.4.7 ACTIVE state

Description:
The PICC is powered and has entered a higher layer mode since a channel number (CID) has been assigned to this PICC through the ATTRIB Command.

It listens to any higher layer message properly formatted (proper CID and valid CRC_B).

The PICC shall not emit subcarrier following any frame with invalid CRC_B or with another CID than the one assigned.

State exit conditions and transitions:
The PICC enters the HALT state when a valid DESELECT Command frame is received.

Specific remarks:
Valid REQB or Slot-MARKER frames shall not be answered.
A valid frame with an ATTRIB Command shall not be answered.
In the higher layer protocol, specific commands may be defined to return the PICC to other states (IDLE or HALT). The PICC may return to these states only following reception of such commands.

7.4.8 HALT state

Description:
The PICC shall respond only to a WAKE-UP Command which brings it back to the idle state.

State exit conditions and transitions:
The PICC returns to the POWER_OFF state if the RF field disappears.

7.5 Command set

Four primitive commands are used to manage multi-node communication channels

- REQB
- Slot-MARKER

- ATTRIB
- HALT

All four commands use the bit and byte formats detailed above.

The commands and the responses of the PICC to these commands are described in the following sections.
Any frame received with a wrong format (wrong frame identifiers or invalid CRC_B) shall be ignored.

7.5.1 Anticollision command format

In order to distinguish all Anticollision commands from application commands, all commands used in the anticollision phase start with the sequence: (101)b.

7.6 ATQB and Slot-MARKER response probability rules

On reception of a valid REQB frame (N being the REQB parameter defining the number of slots):

- If N = 1 and AFI = 0 the PICC shall answer an ATQB and enter the READY-DECLARED state.
- If N is not 1, the PICC shall answer an ATQB with a probability of1/N.
- If AFI is not 0, only PICCs with applications of the type indicated by the AFI may answer.

On reception of a valid Slot-MARKER frame:

- The PICC shall answer an ATQB if its internally defined slot matches the slot marker number.
- Response probability in a particular slot shall not be higher than 1/N (N being the parameter of the last REQB received).

7.7 REQB Command

The REQB Command sent by the PCD is used to probe the field for PICCs of Type B.

The number of slots (or response probability in each slot) N is included in the command as a parameter to optimize the anti-collision algorithm for a given application. Each PICC not in the ACTIVE or HALT states (i.e. in IDLE or READY states) shall process this message and choose which slot it will use (1 out of N possible) to return its ATQB response message.

7.7.1 REQB Command format

Sent by the PCD. Size: 5 Bytes. Format:

APf (1 Byte)	**AFI** (1 Byte)	**PARAM** (1 Byte).	**CRC_B** (2 Bytes)

Figure 7.9 – REQB Command format

Note: Information requiring the most processing is located ahead in order to have more time to process it on-line.

7.7.2 Coding of AntiCollision Prefix Byte APf (« First »)

The AntiCollision Prefix byte is APf = ‘05’ = (0000 0101)b.

7.7.3 Coding of AFI

AFI (Application Family Identifier) represents the type of application targeted by the PCD and is used to preselect PICCs before the ATQB: Only PICCs with applications of the type indicated by the AFI may answer to a REQB Command with AFI different to ‘00’.

When AFI equals ‘00’, all PICCs shall process the REQB

The most significant nibble of AFI is used to code one specific or all application families, as defined in Table 7.1.

The least significant nibble of AFI is used to code one specific or all application sub-families. Sub-family codes different from 0 are proprietary.

Table 7.1 – AFI coding

AFI Most Signif. Nibble	AFI Least Signif. Nibble	Meaning – PICCs respond from	Examples / Note
‘0’	‘0’	All families and sub-families	No application preselection
‘X’	‘0’	All sub-families of family X	Wide application preselection
‘X’	‘Y’	Only the Yth sub-family of family X	
‘0’	‘Y’	Proprietary sub-family Y only	
‘1’	‘0’, ‘Y’	Transport	Mass transit, Bus, Airline,...
‘2’	‘0’, ‘Y’	Financial	IEP, Banking, Retail,...
‘3’	‘0’, ‘Y’	Identification	Access Control,...
‘4’	‘0’, ‘Y’	Telecommunication	Public Telephony, GSM,...
‘5’	‘0’, ‘Y’	Medical	
‘6’	‘0’, ‘Y’	Multimedia	Internet services....
‘7’	‘0’, ‘Y’	Gaming	
‘8’	‘0’, ‘Y’	Data Storage	Portable Files, ...
‘9’-’F’	‘0’, ‘Y’	RFU	

Notes: 1. If AFI=‘00’, all PICCs shall respond (no preselection).
2. X = ‘1’ to ‘F’, Y = ‘1’ to ‘F’

7.7.4 Coding of PARAM

RFU							
b8=0	b7=0	b6=0	b5=0	b4	b3	b2	b1

Figure 7.10 – Coding of PARAM

b4=0: "Normal request" (PICCs in Idle state or Ready state process the Request)
b4=1: "Request All" (PICCs in Idle state or Ready state or HALT state process the Request)

b1 to b3 are used to code the number of slots N according the following table.

Table 7.2 – Coding of N

b3 b2 b1	N
000	$1 = 2^0$
001	$2 = 2^1$
010	$4 = 2^2$
011	$8 = 2^3$
100	$16 = 2^4$
101	RFU
11x	RFU

Note: For each PICC, the probability of response (ATQB) in the first slot shall be 1/N. Thus, if the probabilistic approach is used in the PCD, N is not used to adjust the number of slots but the probability for the PICC to return its ATQB in this unique slot.

7.8 Slot-MARKER Command

After a REQB Command, the PCD may send up to (N-1) slot-markers to define the start of each time slot. To ensure good reliability, each slot-marker includes 2 CRC_B bytes.

It is not mandatory for a PICC to support this command. In this case, the PICC shall ignore any Slot-MARKER command. The PICC may only send its ATQ in the first slot.

Slot-markers can be sent

- after the end of an ATQB message received by the PCD to mark the start of the next slot

- or earlier if no ATQB is received (no need to wait until the end of a slot, if this slot is known to be empty).

7.8.1 Slot-MARKER Command format

Sent by the PCD. Size: 3 bytes. Format:

APn (1 Byte)	**CRC_B** (2 Bytes)

Figure 7.11 – Slot-MARKER Command format

7.8.2 Coding of Anticollision Prefix Byte APn

The Slot-MARKER's first byte is different from the REQB Byte APf.

APn = (nnnn 0101)b where nnnn is the slot-marker number between 1 and 15.

Note: It is not mandatory that the slot-markers are sent sequentially with incremental slot numbers.

7.9 ATQB (Answer to Request - Type B) Response

The response to both REQB and Slot-MARKER Commands is named ATQB (Answer to Request).
It is of fixed size (14 Bytes) and limited duration.
For ATQB only, TR0 as defined in ISO/IEC 14443-2 shall not be greater than 256/fs.

7.9.1 ATQB format

ATQB has the following format:

'50' (1 Byte)	**PUPI** (4 Bytes)	**Application Data** (4 Bytes)	**Protocol Info** (3 Bytes)	**CRC_B** (2 Bytes)

Figure 7.12 – ATQB format

7.9.2 PUPI (Pseudo-Unique PICC Identifier)

A Pseudo-Unique PICC Identifier (PUPI) is used to differentiate PICCs during anticollision. This 4-Byte number may be either a number dynamically generated by the PICC or a diversified fixed number.

7.9.3 Application Data

This field is used to inform the PCD which applications are currently installed in the PICC. This information allows the PCD to select the wanted PICC in the presence of more than one PICC.

7.9.4 Protocol Info

This field indicates the parameters supported by the PICC. It is formatted as detailed below.

Bit_Rate_capability (8 bits)	**Max_Frame_Size** (4 bits)	**Protocol_Type** (4 bits)	**FWI** (4 bits)	**RFU** (2 bits)	**FO** (2 bits)

Figure 7.13 – Protocol Info format format

Bit_Rate_capability (8 bits): see table 7.3

Table 7.3 – Bit rates supported by the PICC

b8	b7	b6	b5	b4	b3	b2	b1	Meaning
0	0	0	0	0	0	0	0	PICC supports only 106 Kbits/s in both directions
1	-	-	-	0	-	-	-	Same bit rate from PCD to PICC and from PICC to PCD compulsory
-	-	-	1	0	-	-	-	PICC to PCD, 1etu = 64 / fc, Bit rate is 212 Kbit/s supported
-	-	1	-	0	-	-	-	PICC to PCD, 1etu = 32 / fc, Bit rate is 424 Kbit/s supported
-	1	-	-	0	-	-	-	PICC to PCD, 1etu = 16 / fc, Bit rate is 847 Kbit/s supported
-	-	-	-	0	-	-	1	PCD to PICC, 1etu = 64 / fc, Bit rate is 212 Kbit/s supported
-	-	-	-	0	-	1	-	PCD to PICC, 1etu = 32 / fc, Bit rate is 424 Kbit/s supported
-	-	-	-	0	1	-	-	PCD to PICC, 1etu = 16 / fc, Bit rate is 847 Kbit/s supported

Max_Frame_Size (4 bits): see table 7.4

Table 7.4 – Maximum frame sizes

Maximum frame size that can be received by the PICC is codded as follows:

Maximum Frame Size Code in ATQB	0	1	2	3	4	5	6	7	8	9-F
Maximum Frame Size (Bytes)	16	24	32	40	48	64	96	128	256	RFU >256

Protocol_Type (4 bits): see table 7.5

Table 7.5 – Protocol Types supported by the PICC

The protocol type that is supported by the PICC is defined as follows:

b4	b3	b2	b1	Meaning
0	0	0	1	PICC supports ISO/IEC 14443-4
0	0	0	0	Other than ISO/IEC 14443-4

Other values are RFU

FWI: Frame Waiting time Integer (4 bits), see ISO/IEC 14443-4

FO: Frame Option (2bits)

Table 7.6 – Frame Option supported by the PICC

b2	b1	Meaning
-	1	NAD supported by PICC
1	-	CID supported by the PICC

7.10 ATTRIB Command

The ATTRIB Command sent by the PCD shall include information required to select a single PICC.

A PICC receiving a ATTRIB Command with its identifier becomes selected and assigned to a dedicated channel. After being selected, this PICC only responds to commands defined in ISO/IEC 14443-4 which include its unique CID.

7.10.1 ATTRIB format

The format of ATTRIB issued by the PCD is as follows:

'1D' (1 byte)	Identifier (4 bytes)	Param 1 (1 byte)	Param 2 (1 byte)	Param 3 (1 byte)	CID (1 byte)	Higher layer INF (optional - variable size)	CRC_B (2 Bytes)

Figure 7.14 – ATTRIB format

7.10.2 Coding of Identifier

This identifier is the value of the PUPI sent by the PICC in the ATQB.

7.10.3 Coding of Param 1

TR0		TR1		EOF	SOF	RFU	
b8	b7	b6	b5	b4	b3	b2	b1

All RFU bits shall be set to zero if not otherwise specified.

Figure 7.15 – Coding of Param 1

EOF/SOF
b3 and b4 indicate the PCD capability to support suppression of the EOF and/or SOF breaks from PICC to PCD, which may reduce communication overhead. The suppression of EOF and/or SOF is optional for the PICC. The coding of b3 and b4 is as follows:

Table 7.7 – SOF/EOF handling

b3	SOF break required
0	yes
1	no

b4	EOF break required
0	yes
1	no

TR0
TR0 indicates to the PICCs the minimum delay before responding after the end of a command sent by a PCD. A default value of 64/fs has been defined in ISO/IEC 14443-2 clause 9.2.5.

Table 7.8 – TR0 codings

TR0	Minimum delay before subcarrier transmission
00	64/fs (default value)
01	48/fs
10	16/fs
11	RFU

Note: This delay depends on the PCD performance: it is required by the PCD when switching from transmit to receive.

TR1
TR1 indicates to the PICCs the minimum delay between subcarrier modulation start and beginning of data transmission. A default value of 80/fs has been defined in ISO/IEC 14443-2 clause 9.2.5.

Table 7.9 – TR1 codings

TR1	Minimum subcarrier duration without modulation
00	80/fs (default value)
01	64/fs

10	16/fs
11	RFU

Note: This delay depends on the PCD performance: it is required by the PCD for synchronization with the PICC.

7.10.4 Coding of Param 2

b1 to b4 are used to code maximum frame size that can be received by the PCD as specified in table 7.10.

Table 7.10 – Coding of b1 to b4 of Param 2

Maximum Frame Size Code in ATQB	0	1	2	3	4	5	6	7	8	9-F
Maximum Frame Size (Bytes)	RFU	RFU	32	40	48	64	96	128	256	RFU >256

b5 to b8 are used for Bit rate selection, as specified in table 7.11.

Table 7.11 – Coding of b5 to b8 of Param 2

b6 b5	Meaning
00	PCD to PICC, 1etu = 128 / fc, Bit rate is 106 kbit/s
01	PCD to PICC, 1etu = 64 / fc, Bit rate is 212 kbit/s
10	PCD to PICC, 1etu = 32 / fc, Bit rate is 424 kbit/s
11	PCD to PICC, 1etu = 16 / fc, Bit rate is 847 kbit/s

b8 b7	Meaning
00	PICC to PCD, 1etu = 128 / fc, Bit rate is 106 kbit/s
01	PICC to PCD, 1etu = 64 / fc, Bit rate is 212 kbit/s
10	PICC to PCD, 1etu = 32 / fc, Bit rate is 424 kbit/s
11	PICC to PCD, 1etu = 16 / fc, Bit rate is 847 kbit/s

7.10.5 Coding of Param 3

b4 b3 b2 b1 = 0001
b8 b7 b6 b5 = RFU = 0000

7.10.6 Coding of CID

The least significant half byte (b4 to b1) is named Card IDentifier (CID) and defines the logical number of the addressed PICC in the range from 0 to 14. The value 15 is RFU. The CID is specified by the PCD and shall be unique for all PICCs, which are in the ACTIVE State at the same time.

7.10.7 High layer INF

Any higher layer command may be included.
It is not mandatory for the PICC to process successfully any command in this context.
The PICC shall however process successfully such message if no application command is included.

7.11 Answer to ATTRIB Command

The PICC shall answer to its first correctly identified PUPI (with valid CRC_B) ATTRIB Command using the higher layer protocol format.

The PICC shall answer to any valid ATTRIB Command with the format described below.

CID	**Higher layer Response**	**CRC_B**
(1 byte)	(optional - variable size)	(2 Bytes)

Figure 7.16 – Format of the Answer to an ATTRIB Command

Note: Size equals the amount of Higher layer data plus 3 protocol bytes

As illustrated below, a PICC shall answer the empty ATTRIB Command with an empty higher layer response:

'1D' (1 byte)	**Identifier** (4 bytes)	**Param 1 to 3** (3 byte)	**CID** (1 byte)	**CRC_B** (2 Bytes)

Figure 7.17 – ATTRIB Command sent by the PCD to a PICC

CID (1 byte)	**CRC_B** (2 Bytes)

Figure 7.18 – PICC Answer to ATTRIB

Notes:

- A properly formatted (valid CID and CRC_B fields) Answer to any ATTRIB Command is the means for a PCD to detect that PICC selection has been successful.
- Higher layer response indicating that the higher layer command is not supported by the PICC within this context is allowed as long as the PICC response meets the format described above.

7.12 HALT Command and Answer

This command is used to place a PICC in HALT state thus no more responding to a « Normal REQB ».
After answering to this command the PICC shall only answer to a « Wake up REQB » command (see section 7.7)

The format of HALT Command issued by the PCD is as follows:

'50' (1 byte)	**Identifier** (4 bytes)	**CRC_B** (2 Bytes)

Figure 7.19 – Format of the HALT Command

The identifier is the value of the PUPI sent by the PICC in the ATQB.

The format of Answer to a HALT Command from the PICC is as follows:

'00' (1 byte)	**CRC_B** (2 Bytes)

Figure 7.20 – PICC Answer to HALT

Annex A
(informative)
Communication example Type A

This example shows the select sequence with 2 PICCs in the field on the assumption of:

- PICC #1 with UID size: single, value of UID0 is ‘10’
- PICC #2 with UID size: double

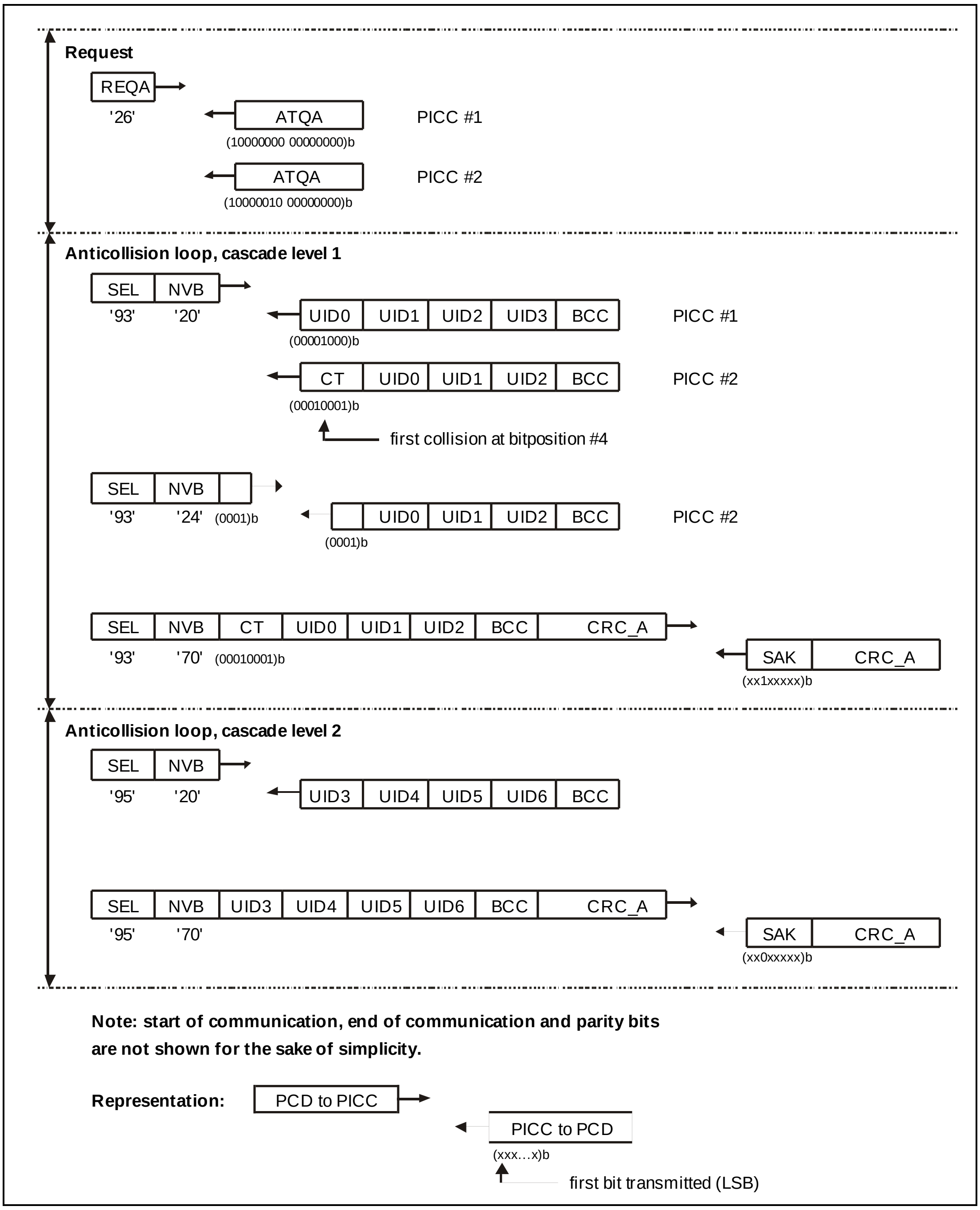

Figure A1 - Select sequence with bit frame anticollision

Explanations to figure A1:

Request

- PCD transmits the REQUEST Command
- All PICCs respond with their ATQA:
  PICC #1 indicates bit frame anticollision and UID size: single
  PICC #2 indicates bit frame anticollision and UID size: double

Anticollision loop, cascade level 1

- PCD transmits an ANTICOLLISION Command:
  SEL specifies bit frame anticollision and cascade level 1
  The value ‘20’ of NVB specifies that the PCD will transmit no part of UID CL1
- Consequently all PICCs in the field response with their complete UID CL1
- Due to the value ‘88’ of the cascade tag, the first collision occurs at bitposition #4
- PCD transmits another ANTICOLLISION Command that includes the first 3 bits of UID CL1 that were received before the collision occurs, followed by a (1)b. Consequently the PCD assigns NVB with the value ‘24’
- These 4 bits correspond to the first bits of UID CL1 of PICC #2
- PICC #2 responds with its 36 remaining bits of UID CL1. Since PICC #1 does not respond, no collision occurs
- Since the PCD "knows" all bits of UID CL1 of PICC #2, it transmits a SELECT Command for PICC #2
- PICC #2 responds with SAK, indicating that UID is not complete
- Consequently, the PCD increases the cascade level

Anticollision loop, cascade level 2

- PCD transmits another ANTICOLLISION Command:
  SEL specifies bit frame anticollision and cascade level 2
  NVB is reset to ‘20’ to force PICC #2 to respond with its complete UID CL2
- PICC #2 responds with all 40 bits of its UID CL2
- PCD transmits the SELECT Command for PICC #2, cascade level 2
- PICC #2 responds with SAK, indicating that UID is complete, and transits from READY State to ACTIVE State

Annex B
(informative)
CRC_A and CRC_B encoding

B.1 CRC_A encoding

This annex is provided for explanatory purposes and indicates the bit patterns that will exist in the physical layer. It is included for the purpose of checking an ISO/IEC 14443-3 Type A implementation of CRC_A encoding.

The process of encoding and decoding may be conveniently carried out by a 16-stage cyclic shift register with appropriate feedback gates. According to ITU-T Recommendation, APPENDIX I, figures I-1/V.41 and I-2/V.41 the flip-flops of the register shall be numbered from FF0 to FF15. FF0 shall be the leftmost flip-flop where data is shifted in. FF15 shall be the rightmost flip-flop where data is shifted out.

Table B1 defines the initial content of the register.

Table B1 - Initial content of 16-stage shift register according to value ‘6363’

FF0	FF1	FF2	FF3	FF4	FF5	FF6	FF7	FF8	FF9	FF10	FF11	FF12	FF13	FF14	FF15
0	1	1	0	0	0	1	1	0	1	1	0	0	0	1	1

Consequently, FF0 corresponds to the MSB and FF15 to the LSB.

B.1.1 Examples of bit patterns that will be transmitted via standard frames

Example 1: Transmission of data, first byte = ‘00’, second byte = ‘00’, CRC_A appended.
Calculated CRC_A = ‘1EA0’

First bit transmitted

↓

S	0000 0000	1	0000 0000	1	0000 0101	1	0111 1000	1	E
	‘00’	P	‘00’	P	‘A0’	P	‘1E’	P	

Figure B1 - Example 1 for CRC_A encoding

Table B2 - Content of 16-stage shift register according to value ‘1EA0’

FF0	FF1	FF2	FF3	FF4	FF5	FF6	FF7	FF8	FF9	FF10	FF11	FF12	FF13	FF14	FF15
0	0	0	1	1	1	1	0	1	0	1	0	0	0	0	0

Example 2: Transmission of datablock, first byte = ‘12’, second byte = ‘34’, CRC_A appended.
Calculated CRC_A = ‘CF26’

First bit transmitted

↓

S	0100 1000	1	0010 1100	0	0110 0100	0	1111 0011	1	E
	‘12’	P	‘34’	P	‘26’	P	‘CF’	P	

Figure B2 - Example 2 for CRC_A encoding

Table B3 - Content of 16-stage shift register according to value 'CF26'

FF0	FF1	FF2	FF3	FF4	FF5	FF6	FF7	FF8	FF9	FF10	FF11	FF12	FF13	FF14	FF15
1	1	0	0	1	1	1	1	0	0	1	0	0	1	1	0

B.2 CRC_B encoding

This annex is provided for explanatory purposes and indicates the bit patterns that will exist in the physical layer. It is included for the purpose of checking an ISO/IEC 14443-3 Type B implementation of CRC_B encoding. Refer to ISO/IEC 3309 and CCITT X.25 #2.2.7 and V.42 #8.1.1.6.1 for further details.

Initial Value = 'FFFF'

B.2.1 Examples of bit patterns that will be transmitted via standard frames

Example 1: Transmission of first data byte = '00', second data byte = '00', third data byte = '00', CRC_B appended.

Calculated CRC_B = 'CCC6'

		1st Data Byte	2nd Data Byte	3rd Data Byte	CRC_B		
Frame =	SOF	'00'	'00'	'00'	'CC'	'C6'	EOF

Figure B3 - Example 1 for CRC_B encoding

Example 2: Transmission of first data byte = '0F', second data byte = 'AA', third data byte = 'FF', CRC_B appended.

Calculated CRC_B = 'FCD1'

		1st Data Byte	2nd Data Byte	3rd Data Byte	CRC_B		
Frame =	SOF	'0F'	'AA'	'FF'	'FC'	'D1'	EOF

Figure B4 - Example 2 for CRC_B encoding

Example 3: Transmission of first data byte = '0A', second data byte = '12', third data byte = '34', fourth data byte = '56', CRC_B appended.

Calculated CRC_B = '2CF6'

		1st Data Byte	2nd Data Byte	3rd Data Byte	4th Data Byte	CRC_B		
Frame =	SOF	'0A'	'12'	'34'	'56'	'2C'	'F6'	EOF

Figure B5 - Example 3 for CRC_B encoding

B.3 Code sample written in C language for CRC calculation

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <ctype.h>

#define CRC_A 1
#define CRC_B 2
#define BYTE unsigned char

unsigned short UpdateCrc(unsigned char ch, unsigned short *lpwCrc)
{
  ch = (ch^(unsigned char)((*lpwCrc) & 0x00FF));
  ch = (ch^(ch<<4));

  *lpwCrc = (*lpwCrc >> 8)^((unsigned short)ch << 8)^((unsigned
short)ch<<3)^((unsigned short)ch>>4);

  return(*lpwCrc);
}

void ComputeCrc(int CRCType, char *Data, int Length,
  BYTE *TransmitFirst, BYTE *TransmitSecond)
{
  unsigned char chBlock;
  unsigned short wCrc;

  switch(CRCType) {
    case CRC_A:
      wCrc = 0x6363;  // ITU-V.41
      break;
    case CRC_B:
      wCrc = 0xFFFF;  // ISO 3309
      break;
    default:
      return;
  }

  do {
    chBlock = *Data++;
    UpdateCrc(chBlock, &wCrc);
  } while (--Length);
  if (CRCType == CRC_B)
    wCrc = ~wCrc; // ISO 3309

  *TransmitFirst = (BYTE) (wCrc & 0xFF);
  *TransmitSecond = (BYTE) ((wCrc >> 8) & 0xFF);

  return;
}

BYTE BuffCRC_A[10] = {0x12, 0x34};
BYTE BuffCRC_B[10] = {0x0A, 0x12, 0x34, 0x56};
unsigned short Crc;
BYTE First, Second;
FILE *OutFd;
int i;

int main(void)
{
  printf("CRC-16 reference results 3-Jun-1999\n");
```

```
  printf("by Mickey Cohen - mickey@softchip.com\n\n");
  printf("Crc-16 G(x) = x^16 + x^12 + x^5 + 1\n\n");

  printf("CRC_A of [ ");
  for(i=0; i<2; i++) printf("%02X ",BuffCRC_A[i]);
  ComputeCrc(CRC_A, BuffCRC_A, 2, &First, &Second);
  printf("] Transmitted: %02X then %02X.\n", First, Second);

  printf("CRC_B of [ ");
  for(i=0; i<4; i++) printf("%02X ",BuffCRC_B[i]);
  ComputeCrc(CRC_B, BuffCRC_B, 4, &First, &Second);
  printf("] Transmitted: %02X then %02X.\n", First, Second);

  return(0);
}
```

Annex C
(informative)
Type A_timeslot – Initialization and anticollision

This annex describes the timeslot detection protocol applicable for PICCs of type A. A PCD supporting Polling for both of Type A and Type B is not required to support this detection protocol as a mandatory anticollision protocol as described in clause 5.

C.1 Terms and abbreviations

See clause 3, and clause. The following are specific to this section of ISO/IEC 14443-3.

ATQA_t	Answer To reQuest of Type A_ timeslot
ATQ-ID	Answer To REQ-ID
CID_t	Card IDentifier of Type A_timeslot
HALT_t	HALT Command of Type A_timeslot
REQA_t	REQuest Command of Type A_timeslot
REQ-ID	REQuest-ID Command
SAK_t	Select AKnowledge of Type A_timeslot
SEL_t	SELect Command of Type A_timeslot

C.2 Bit, byte and frame format

C.2.1 Timing definitions

C.2.1.1 Polling reset time

Polling reset times of Type A_timeslot are equal to those of Type A in clause 5.

C.2.1.2 Time interval from REQA_t to ATQA_t

PICC returns ATQA_t after waiting for 32+/-2 etu upon receiving REQA_t. The PCD may not recognize the coding of the ATQA_t.

C.2.1.3 Request Guard Time

The Request Guard Time is defined as the minimum time between the start of bits of two consecutive Request commands. Its value shall be 0,5 ms.

C.2.1.4 Frame Guard Time

The Frame Guard Time is defined as the minimum time between the rising edge of the last bit and the falling edge of the start bit of two consecutive frames in opposite direction. Its value shall be 10 etu.

C.2.1.5 Timeslot length

The first timeslot starts in 32 etu after REQ-ID. Each timeslot length is 104 etu consisting of 94 etu for ATQ-ID reception and 10 etu frame guard time succeeding.

C.2.2 Frame formats

C.2.2.1 REQA_t frame

See 6.1.7 and table 6.2. The data content is ‘35’ for a REQA_t.

C.2.2.2 Standard frame

The LSB of each data byte is transmitted first. Each data byte has no parity. CRC_B is defined in subclause 7.2.

S	data: n *(8 data bits +no parity) 1byte command or response	(0 or 1byte) (parameter 1)	(0 or 1 byte) (parameter 2)	(0 or 8 byte) (UID)	CRC_B 2 byte	E

C.3 PICC states

The following clauses provide the states for a PICC, Type A_timeslot.

C.3.1 POWER-OFF state

In the POWER-OFF state, the PICC is not energised due to lack of carrier and shall not emit subcarrier.

C.3.2 IDLE state

This state is entered after the field has been active for a 5 ms delay.

C.3.3 READY state

This state is entered by REQA_t.

C.3.4 ACTIVE state

This state is entered by SEL_t with its complete UID and CID_t. The PCD acquires the SAK_t information from the PICC.

C.3.5 HALT state

This state is entered by HALT_t from ACTIVE State. In this state, the PICC is mute.

C.4 Command/response set

Four sets of command and response are used.

Type	Name	Coding (b8-b1)	Meaning
Command	REQA_t	(b7-b1) (0110101)b (=‘35’)	Request PICC Type A timeslot to answer ATQA_t. REQA_t is accompanied by two parameters.
Response	ATQA_t	any one-byte content of ‘00’ to ‘FF’	Answer to REQA_t. PCD can recognise the existence of Type A timeslot PICC. However, the PCD is not required to recognise the coding of the ATQA_t.
Command	REQ-ID	(00001000)b (= ‘08’)	Request the PICC to answer its UID to one of timeslots
Response	ATQ-ID	(00000110)b (= ‘06’)	Answer 8-byte UID to one of 4 timeslots. ATQ-ID is accompanied by its 8-byte UID
Command	SEL_t	(01000NNN)b, (NNN=CID_t No.(0-7)) (01100NNN)b, (NNN+8=CID_t No.(8-15))	Select the PICC with its UID and set the CID_t. SEL_t is accompanied by 8-byte UID
Response	SAK_t	(1000xxxx)b (=‘8X’, ‘X’= ‘0’unless	Acknowledge SEL_t*

		otherwise specified)	
Command	HALT_t	(00011NNN)b, (NNN=CID_t No.(0-7)) (00111NNN)b, (NNN+8=CID_t No.(8-15))	Halt the PICC with its CID_t and release its CID_t.
Response	Answer to HALT_t	(00000110)b (= '06')	Acknowledge HALT_t

* Additional information available. Details are to be specified in ISO/IEC 14443-4.

Parameters of REQ-ID Command

Parameters		Meaning
P1	b8-b7	Timeslot length, b7=1: for 8-byte UID, b8=0
	b6-b1	Number of timeslots,.b3=1:for 4 timeslots, Others=0
P2		'00'

C.5 Timeslot anticollision sequence

The flow chart of sequence is shown as below in figure C1.

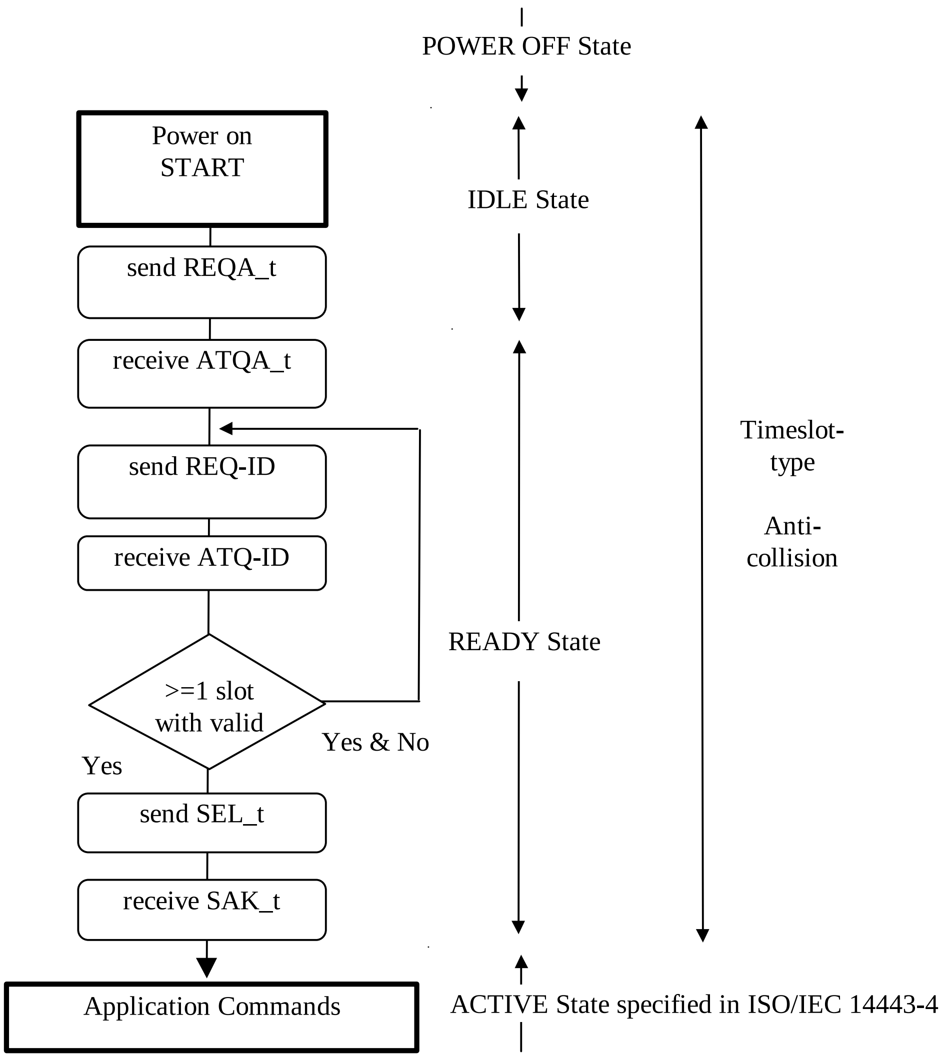

Figure C1 - Flow chart of Timeslot-type Anticollision

Annex D
(informative)
Detailed PICC Type A State Diagram

This informative annex describes a detailed state diagram for type A including substates which are not defined in the main body of the standard. This state diagram takes all possible state transitions caused by commands of this part of 14443 into account. Transmission error-handling is not included.

The following symbols apply for detailed state diagram shown in figure D1 below.

REQA	REQA Command
WUP	WAKE-UP Command
AC	ANTICOLLISION Command (matched UID)
nAC	ANTICOLLISION Command (not matched UID)
SEL	SELECT Command (matched UID)
nSEL	SELECT Command (not matched UID)
HALT	HALT Command
DESEL	DESELECT Command, defined in ISO/IEC 14443-4

PICCs being compliant with ISO/IEC 14443-3 but not using ISO/IEC 14443-4 may leave the SELECTED States by proprietary commands.

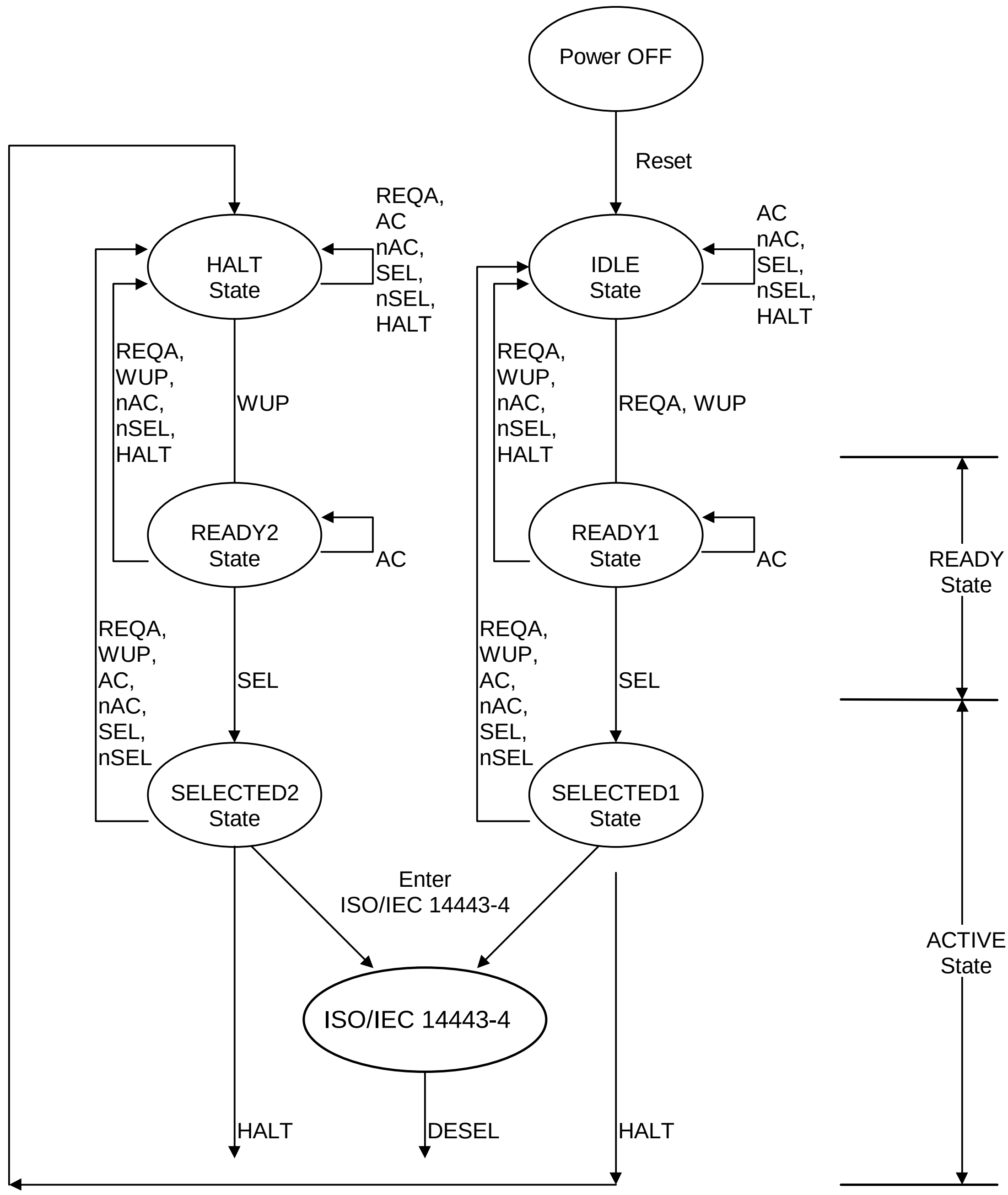

Figure D1 - Detailed PICC Type A state diagram

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Subject:	Committee Draft 14443-3
Author:	Un client important pour Microsoft
Keywords:	Proximity IC cards
Comments:	
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Change Number:	3
Last Saved On:	11.06.99 13:02
Last Saved By:	ZKT
Total Editing Time:	1 Minute
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Number of Words:	9.795 (approx.)
Number of Characters:	55.833 (approx.)