

Identification cards — Contactless integrated circuit cards — Proximity cards

Part 4: Transmission protocol

ICS 35.240.15

National foreword

This British Standard is the UK implementation of ISO/IEC 14443-4:2008+A4:2014. It supersedes BS ISO/IEC 14443-4:2008+A3:2013 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to ISO/IEC text carry the number of the ISO/IEC amendment. For example, text altered by ISO/IEC amendment 1 is indicated by **A1** **A1**.

The UK participation in its preparation was entrusted to Technical Committee IST/17, Cards and personal identification.

A list of organizations represented on this committee can be obtained on request to its secretary.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 August 2008

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Published by BSI Standards Limited 2014

ISBN 978 0 580 81569 0

Amendments/corrigenda issued since publication

Date	Comments
31 May 2009	Correction to ISO ratified text printed
30 April 2012	Implementation of ISO/IEC amendment 1:2012
30 November 2012	Implementation of ISO/IEC amendment 2:2012
31 October 2013	Implementation of ISO/IEC amendment 3:2013: Clause 9 updated and Annex D added
30 April 2014	Implementation of ISO/IEC amendment 4:2014

**Identification cards – Contactless
integrated circuit cards – Proximity
cards –**

**Part 4:
Transmission protocol**

*Cartes d'identification – Cartes à circuit(s) intégré(s) sans contact —
Cartes de proximité —*

Partie 4: Protocole de transmission



Reference number
ISO/IEC 14443-4:2008(E)

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Published in Switzerland

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Foreword

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

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

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

ISO/IEC 14443-4 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 17, *Cards and personal identification*.

This second edition cancels and replaces the first edition (ISO/IEC 14443-4:2001). It also incorporates the Amendment ISO/IEC 14443-4:2001/Amd.1:2006.

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

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

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.

The protocol as defined in this part of ISO/IEC 14443 is capable of transferring the application protocol data units as defined in ISO/IEC 7816-4. Thus, application protocol data units may be mapped as defined in ISO/IEC 7816-4 and application selection may be used as defined ISO/IEC 7816-5.

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 and Near Field Communication (NFC) devices conforming to ISO/IEC 18092 and ISO/IEC 21481.

The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) draw attention to the fact that it is claimed that compliance with this document may involve the use of patents.

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A system and method for the non-contact
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Identification cards – Contactless integrated circuit cards – Proximity cards –

Part 4: Transmission protocol

1 Scope

This part of ISO/IEC 14443 specifies a half-duplex block transmission protocol featuring the special needs of a contactless environment and defines the activation and deactivation sequence of the protocol.

This part of ISO/IEC 14443 is intended to be used in conjunction with other parts of ISO/IEC 14443 and is applicable to proximity cards or objects of Type A and Type B.

2 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 7816-3, *Identification cards – Integrated circuit cards – Part 3: Cards with contacts – Electrical interface and transmission protocols*

ISO/IEC 7816-4, *Identification cards – Integrated circuit cards – Part 4: Organization, security and commands for interchange*

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

ISO/IEC 14443-3, *Identification cards – Contactless integrated circuit cards – Proximity cards – Part 3: Initialization and anticollision*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

bit duration

one elementary time unit (etu), calculated by the following formula:

$$1 \text{ etu} = 128 / (D \times fc)$$

the initial value of the divisor D is 1, giving the initial etu as follows:

$$1 \text{ etu} = 128 / fc$$

where *fc* is the carrier frequency as defined in ISO/IEC 14443-2.

3.2

block

special type of frame, which contains a valid protocol data format

NOTE A valid protocol data format includes I-blocks, R-blocks or S-blocks.

3.3

invalid block

type of frame, which contains an invalid protocol format

NOTE A time-out, when no frame has been received, is not interpreted as an invalid block.

3.4

frame

sequence of bits as defined in ISO/IEC 14443-3

NOTE  The PICC independent from its type may use the frame with error correction defined in clause 10. Alternatively the PICC Type A may use one of the standard frames defined for Type A and the PICC Type B may use the frame defined for Type B. This Type B frame is called standard frame, too, within this specification. 

4 Symbols and abbreviated terms

 A	Hamming control bits generation matrix (6 rows, 56 columns) 
ACK	positive ACKnowledgement
ATS	Answer To Select
ATQA	Answer To reQuest, Type A
ATQB	Answer To reQuest, Type B
CID	Card IDentifier
CRC	Cyclic Redundancy Check, as defined for each PICC Type in ISO/IEC 14443-3
CRC1	most significant byte of CRC (b16 to b9)
CRC2	least significant byte of CRC (b8 to b1)
 CRC_32	Cyclic Redundancy Check error detection code used within enhanced block
c_n	Hamming control bit n
$\underline{d}$	vector containing 56 data bits 
D	Divisor
 d_n	data bit n 
DR	Divisor Receive (PCD to PICC)
DRI	Divisor Receive Integer (PCD to PICC)
DS	Divisor Send (PICC to PCD)
DSI	Divisor Send Integer (PICC to PCD)
EDC	Error Detection Code

etu	elementary time unit
f_c	carrier frequency
FSC	Frame Size for proximity Card
FSCI	Frame Size for proximity Card Integer
FSD	Frame Size for proximity coupling Device
FSDI	Frame Size for proximity coupling Device Integer
FWI	Frame Waiting time Integer
FWT	Frame Waiting Time
FWT_{TEMP}	temporary Frame Waiting Time
$\langle A_4 \rangle H$	matrix needed to calculate Hamming syndrome $\underline{s}$ (6 rows, 62 columns)
$h'_{m,n}$	element in row m and column n of matrix H'
H'	matrix needed to get matrix A (6 rows, 62 columns)
$\underline{h}'_n$	column vector of matrix H' $\langle A_4 \rangle$
HLTA	HALT command, Type A
$\langle A_4 \rangle I_{6 \times 6}$	6 by 6 Identify matrix $\langle A_4 \rangle$
I-block	Information block
INF	INformation Field
$\langle A_4 \rangle LEN$	two bytes LENgth field used within enhanced block
m	row index $\langle A_4 \rangle$
MAX	index to define a maximum value
MIN	index to define a minimum value
$\langle A_4 \rangle n$	column index $\langle A_4 \rangle$
NAD	Node ADdress
NAK	Negative AcKnowledgement
OSI	Open Systems Interconnection
PCB	Protocol Control Byte
PCD	Proximity Coupling Device
PICC	proximity card or object
PPS	Protocol and Parameter Selection
PPSS	Protocol and Parameter Selection Start
PPS0	Protocol and Parameter Selection parameter 0

PPS1	Protocol and Parameter Selection parameter 1
R-block	Receive ready block
R(ACK)	R-block containing a positive acknowledge
R(NAK)	R-block containing a negative acknowledge
RATS	Request for Answer To Select
REQA	REQuest Command, Type A
RFU	Reserved for Future Use by ISO/IEC
S-block	Supervisory block
SAK	Select AcKnowledge
SFGI	Start-up Frame Guard time Integer
SFGT	Start-up Frame Guard Time
 SYNC	SYNChronization sequence
<u>s</u>	6-bit vector containing Hamming syndrome
s'	error position code
s	error position 
WUPA	Wake-UP command, Type A
WTX	Waiting Time eXtension
WTXM	Waiting Time eXtension Multiplier
 <u>y</u>	62-bit vector (<u>y</u> ' with no padding bits)
<u>y</u> '	64-bit vector containing received modified Hamming sub-block
<u>y</u> ' _n	received bit n in each modified Hamming sub-block 

For the purposes of this document, the following notation applies:

- (xxxxx)b Data bit representation;
- 'XY' Hexadecimal notation, equal to XY to the base 16.

5 Protocol activation of PICC Type A

The following activation sequence shall be applied:

- PICC activation sequence as defined in ISO/IEC 14443-3 (request, anticollision loop and select).
-  — The SAK byte shall be checked to get information if the PICC is compliant with ISO/IEC 14443-4. The SAK byte is defined in ISO/IEC 14443-3.
- The PICC may be set to HALT state, using the HLTA command as defined in ISO/IEC 14443-3, if e.g. no ISO/IEC 14443-4 protocol is used at PCD.

NOTE The PCD cannot continue the activation sequence in that case.

- If the PICC is compliant to ISO/IEC 14443-4, the RATS may be sent by the PCD as next command after receiving the SAK. ^{A2}
- The PICC shall send its ATS as answer to the RATS. The PICC shall only answer to the RATS if the RATS is received directly after the selection.
- If the PICC supports any changeable parameters in the ATS, a PPS request may be used by the PCD as the next command after receiving the ATS to change parameters.
- The PICC shall send a PPS Response as answer to the PPS request.

A PICC does not need to implement the PPS, if it does not support any changeable parameters in the ATS.

The PCD activation sequence for a PICC Type A is shown in Figure 1.

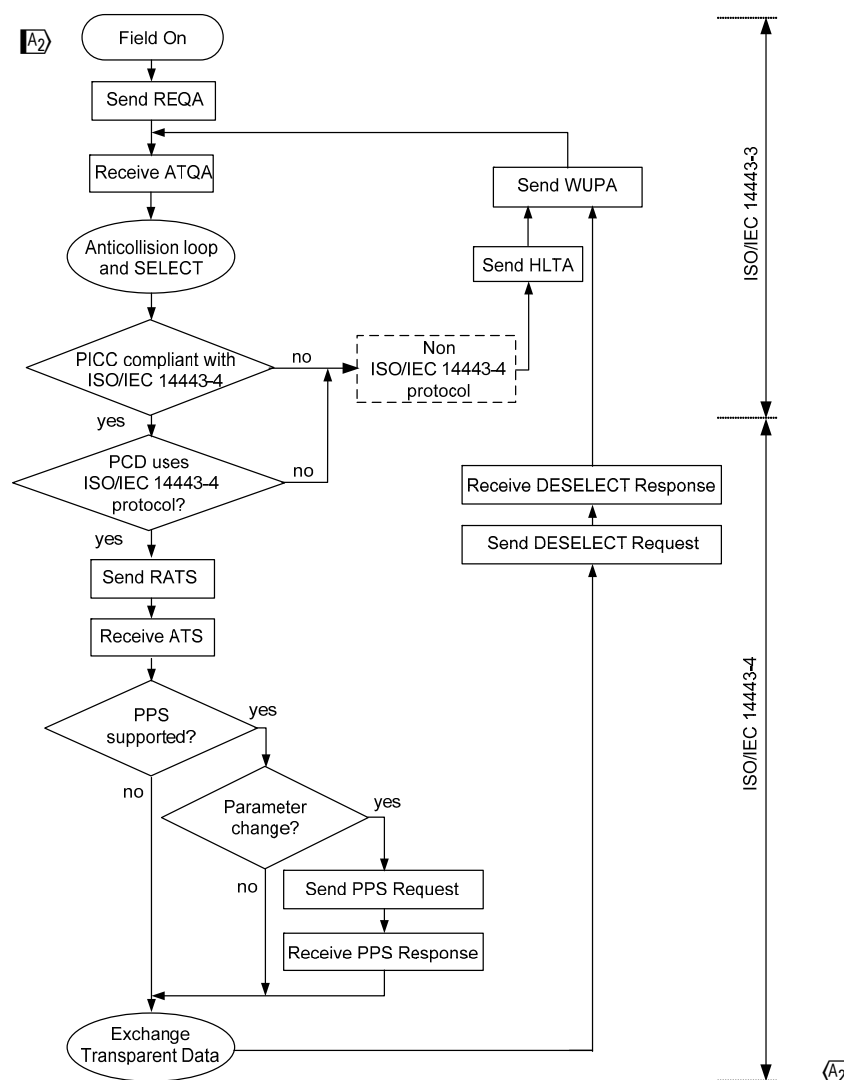


Figure 1 – Activation of a PICC Type A by a PCD

5.1 Request for answer to select

This clause defines the RATS with all its fields (see Figure 2).

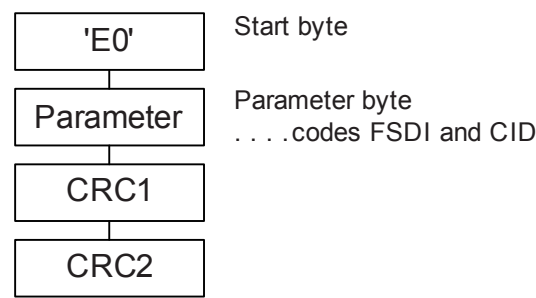


Figure 2 – Request for answer to select

The parameter byte consists of two parts (see Figure 3):

- The most significant half-byte b8 to b5 is called FSDI and codes FSD. The FSD defines the maximum size of a frame the PCD is able to receive. The coding of FSD is given in Table 1.

A2 — A PCD setting FSDI = 'D'-'F' is not compliant with this standard. Until the RFU values 'D' - 'F' are assigned by ISO/IEC, a PICC receiving value of FSDI = 'D' - 'F' should interpret it as FSDI = 'C' (FSD = 4096 bytes).

NOTE This PCD recommendation is added for PCD's compatibility with future PICCs when ISO/IEC defines the behavior for the RFU values of 'D' - 'F'. **A2**

- The least significant half byte b4 to b1 is named CID and it 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. The CID is fixed for the time the PICC is active and the PICC shall use the CID as its logical identifier, which is contained in the first error-free RATS received.
- A PCD setting CID = 15 is not compliant with this standard. For PICC behaviour see 5.6.1.2 (c).

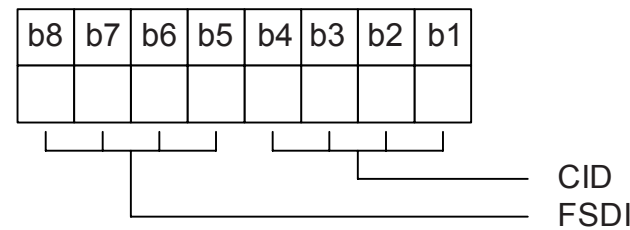


Figure 3 – Coding of RATS parameter byte

A2 Table 1 — FSDI to FSD conversion

FSDI	'0'	'1'	'2'	'3'	'4'	'5'	'6'	'7'	'8'	'9'	'A'	'B'	'C'	'D' – 'F'
FSD (bytes)	16	24	32	40	48	64	96	128	256	512	1024	2048	4096	RFU

A2

5.2 Answer to select

This clause defines the ATS with all its available fields (see Figure 4).

In the case that one of the defined fields is not present in an ATS sent by a PICC the default values for that field shall apply.

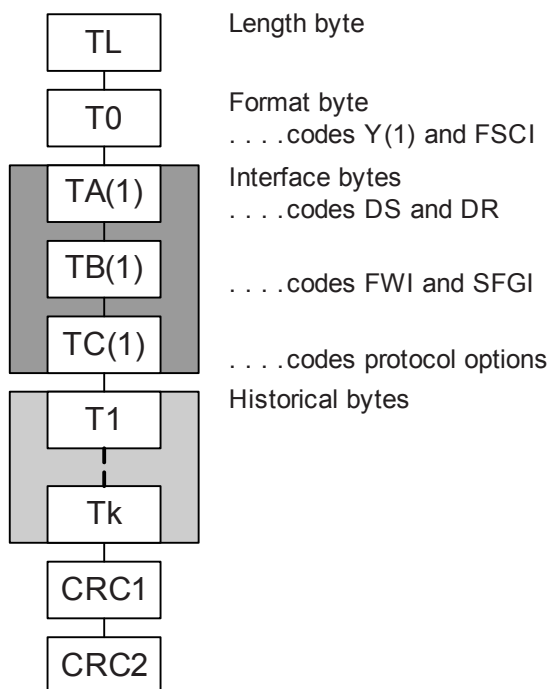


Figure 4 – Structure of the ATS

5.2.1 Structure of the bytes

The length byte TL is followed by a variable number of optional subsequent bytes in the following order:

- format byte T0,
- interface bytes TA(1), TB(1), TC(1) and
- historical bytes T1 to Tk.

5.2.2 Length byte

The length byte TL is mandatory and specifies the length of the transmitted ATS including itself. The two CRC bytes are not included in TL. The maximum size of the ATS shall not exceed the indicated FSD. Therefore the maximum value of TL shall not exceed FSD-2.

5.2.3 Format byte

The format byte T0 is optional and is present as soon as the length is greater than 1. The ATS can only contain the following optional bytes when this format byte is present.

T0 consists of three parts (see Figure 5):

- The most significant bit b8 shall be set to 0. The value 1 is RFU.
- The bits b7 to b5 contain Y(1) indicating the presence of subsequent interface bytes TC(1), TB(1) and TA(1).

- The least significant half byte b4 to b1 is called FSCI and codes FSC. The FSC defines the maximum size of a frame accepted by the PICC. The default value of FSCI is 2 and leads to a FSC of 32 bytes. The coding of FSC is equal to the coding of FSD (see Table 1).

- A2** — A PICC setting FSCI = 'D'-'F' is not compliant with this standard. Until the RFU values 'D'-'F' are assigned by ISO/IEC, a PCD receiving value of FSCI = 'D' - 'F' should interpret it as FSCI = 'C' (FSC = 4096 bytes).

NOTE This PICC recommendation is added for PICC's compatibility with future PCDs when ISO/IEC defines the behavior for the RFU values of 'D' - 'F'. **A2**

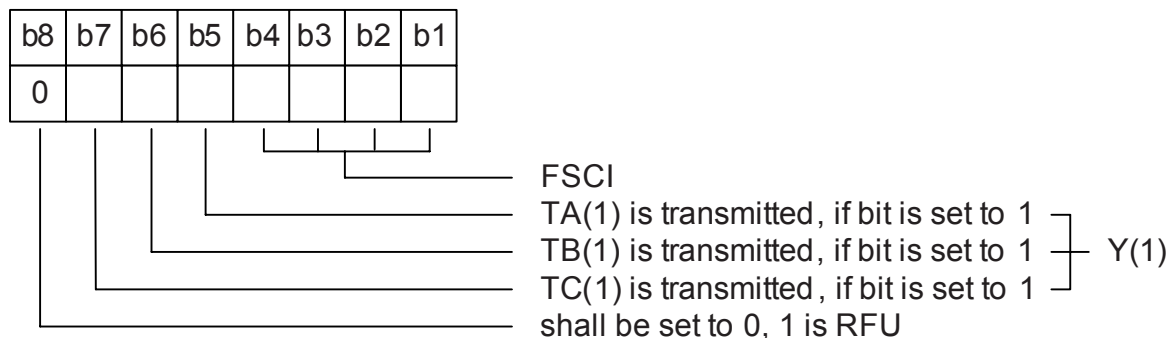


Figure 5 – Coding of format byte

5.2.4 Interface byte TA(1)

The interface byte TA(1) consists of four parts (see Figure 6):

- The most significant bit b8 codes the possibility to handle different divisors for each direction. When this bit is set to 1 the PICC is unable to handle different divisors for each direction.
- The bits b7 to b5 code the bit rate capability of the PICC for the direction from PICC to PCD, called DS. The default value shall be (000)b.
- The bit b4 shall be set to (0)b and the other value is RFU.
- The bits b3 to b1 code the bit rate capability of the PICC for the direction from PCD to PICC, called DR. The default value shall be (000)b.

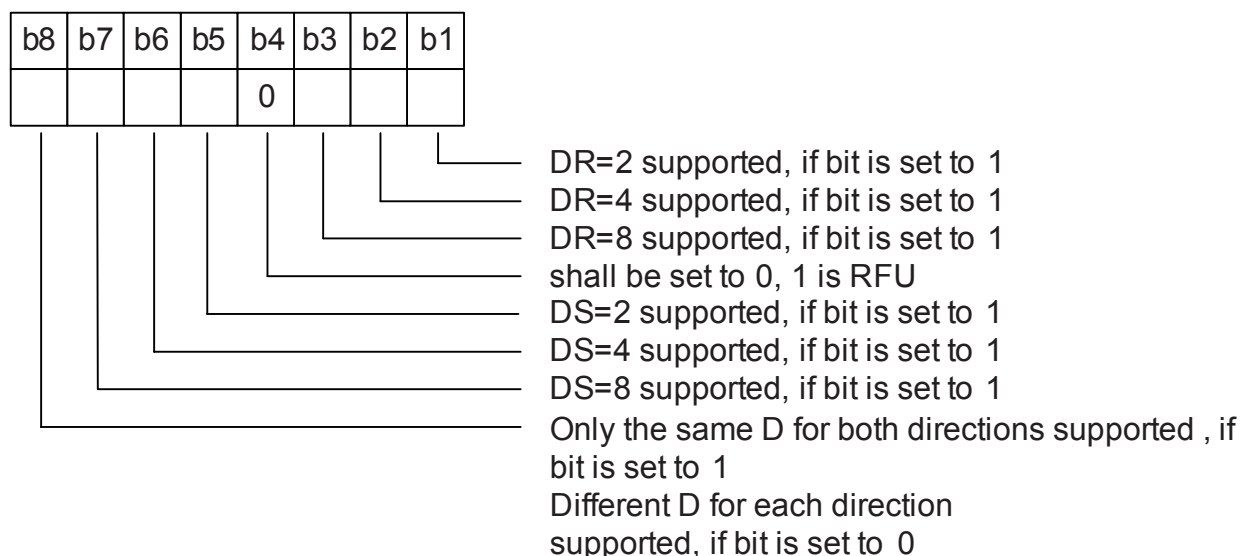


Figure 6 – Coding of interface byte TA(1)

The selection of a specific divisor D for each direction may be done by the PCD using a PPS.

A PICC setting $b_4 = 1$ is not compliant with this standard. A received value of $TA(1)$ with $b_4 = 1$ should be interpreted by the PCD as $(b_8 \text{ to } b_1) = (00000000)_b$ (only ~106 kbit/s in both directions).

5.2.5 Interface byte TB(1)

The interface byte TB(1) conveys information to define the frame waiting time and the start-up frame guard time.

The interface byte TB(1) consists of two parts (see Figure 7):

- The most significant half-byte b_8 to b_5 is called FWI and codes FWT (see 7.2).
- The least significant half byte b_4 to b_1 is called SFGI and codes a multiplier value used to define the SFGT. The SFGT defines a specific guard time needed by the PICC before it is ready to receive the next frame after it has sent the ATS. SFGI is coded in the range from 0 to 14. The value of 15 is RFU. The value of 0 indicates no SFGT needed and the values in the range from 1 to 14 are used to calculate the SFGT with the formula given below. The default value of SFGI is 0.

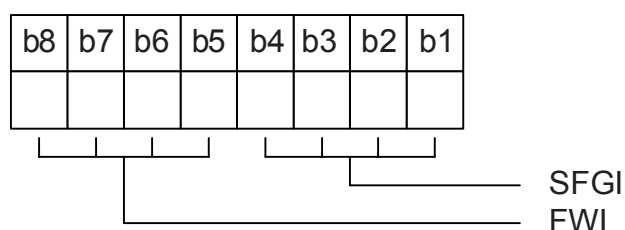


Figure 7 – Coding of interface byte TB(1)

SFGT is calculated by the following formula:

$$SFGT = (256 \times 16 / f_c) \times 2^{SFGI}$$

$SFGT_{MIN}$ = minimum value of the frame delay time as defined in ISO/IEC 14443-3

$SFGT_{DEFAULT}$ = minimum value of the frame delay time as defined in ISO/IEC 14443-3

$$SFGT_{MAX} = (256 \times 16 / f_c) \times 2^{14} (\sim 4949 \text{ ms})$$

A PICC setting $SFGI = 15$ is not compliant with this standard. Until the RFU value 15 is assigned by ISO/IEC, a PCD receiving $SFGI = 15$ should interpret it as $SFGI = 0$.

A PICC setting $FWI = 15$ is not compliant with this standard. Until the RFU value 15 is assigned by ISO/IEC, a PCD receiving $FWI = 15$ should interpret it as $FWI = 4$.

5.2.6 Interface byte TC(1)

The interface byte TC(1) specifies a parameter of the protocol.

The specific interface byte TC(1) consists of two parts (see Figure 8):

- The most significant bits b_8 to b_3 shall be $(000000)_b$ and all other values are RFU.
- The bits b_2 and b_1 define which optional fields in the prologue field a PICC does support. The PCD is allowed to skip fields, which are supported by the PICC, but a field not supported by the PICC shall never be transmitted by the PCD. The default value shall be $(10)_b$ indicating CID supported and NAD not supported.
- A PICC setting $(b_8 \text{ to } b_3) \neq (000000)_b$ is not compliant with this standard. The PCD should ignore $(b_8 \text{ to } b_3)$ and its interpretation of (b_2, b_1) or of any other field of the whole frame shall not change.

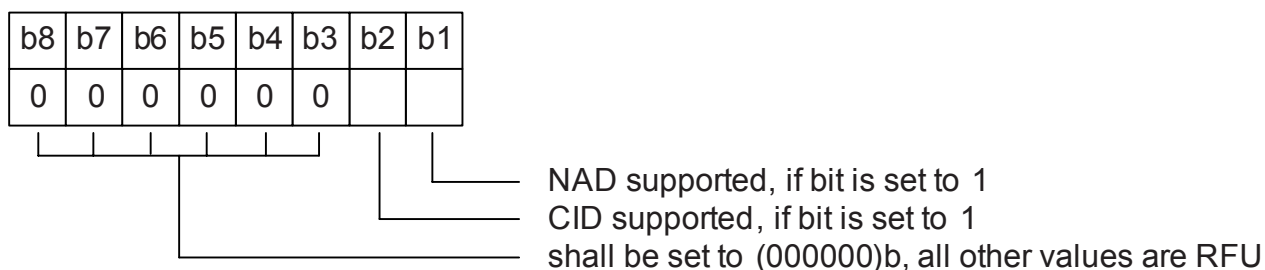


Figure 8 – Coding of interface byte TC(1)

5.2.7 Historical bytes

The historical bytes T1 to Tk are optional and designate general information. The maximum length of the ATS gives the maximum possible number of historical bytes. ISO/IEC 7816-4 specifies the content of the historical bytes.

5.3 Protocol and parameter selection request

PPS request contains the start byte that is followed by two parameter bytes (see Figure 9).

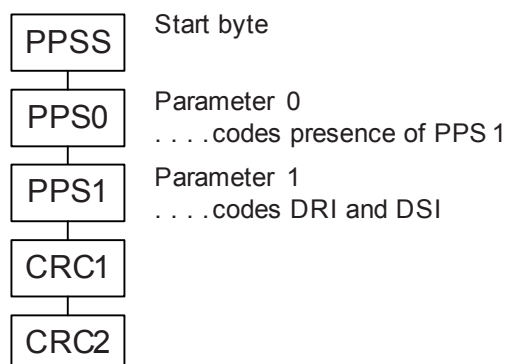


Figure 9 – Protocol and parameter selection request

5.3.1 Start byte

PPSS consists of two parts (see Figure 10):

- The most significant half byte b8 to b5 shall be set to (1101)b and identifies the PPS.
- The least significant half byte b4 to b1 is named CID and it defines the logical number of the addressed PICC.

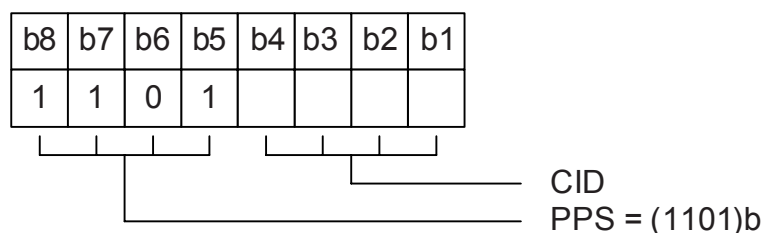


Figure 10 – Coding of PPSS

5.3.2 Parameter 0

PPS0 indicates the presence of the optional byte PPS1 (see Figure 11).

A PCD setting (b4 to b1) $\neq$ (0001)b and/or setting (b8 to b6) $\neq$ (000)b is not compliant with this standard. A PICC receiving (b4 to b1) $\neq$ (0001)b and/or receiving (b8 to b6) $\neq$ (000)b shall apply 5.6.2.2 (b).

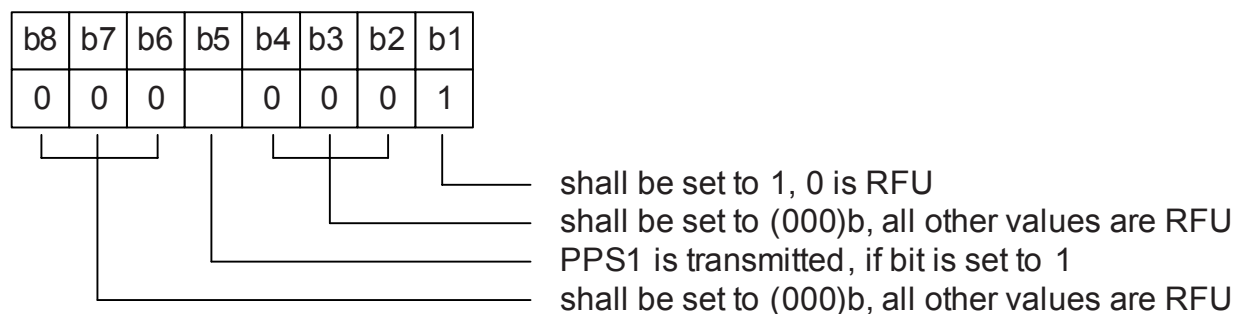


Figure 11 – Coding of PPS0

5.3.3 Parameter 1

PPS1 consists of three parts (see Figure 12):

- The most significant half byte b8 to b5 shall be (0000)b and all other values are RFU.
- The bits b4 and b3 are called DSI and code the selected divisor integer from PICC to PCD.
- The bits b2 and b1 are called DRI and code the selected divisor integer from PCD to PICC.
- A PCD setting (b8 to b5) $\neq$ (0000)b is not compliant with this standard. A PICC receiving (b8 to b5) $\neq$ (0000)b shall apply 5.6.2.2 (b).

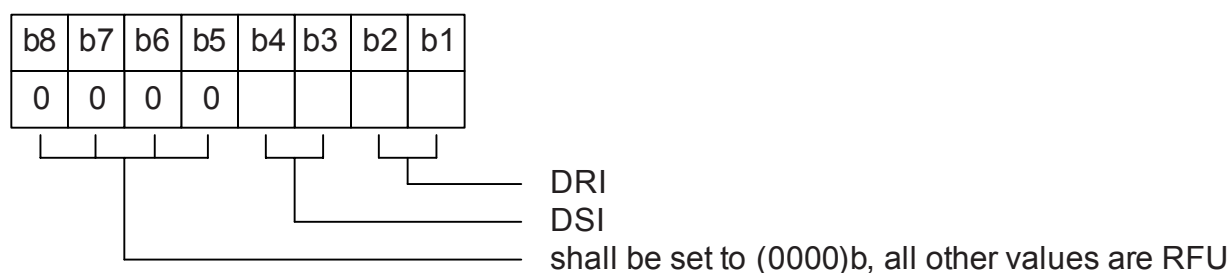


Figure 12 – Coding of PPS1

For the definition of DS and DR, see 5.2.4.

The coding of D is given in Table 2.

Table 2 – DRI, DSI to D conversion

DRI, DSI	(00)b	(01)b	(10)b	(11)b
D	1	2	4	8