AN130810

mifare ISO/IEC 14443 PICC Selection

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Document information

Info	Content
Keywords	Activate Card, mifare, Select Card
Abstract	This Application Note shows the elementary communication for selecting a Contactless Smart Card according to the ISO/IEC 14443, and how to use this communication to guarantee proper functionality in different applications.

founded by Philips

Revision history

Rev	Date	Description
1.0	20061017	Initial Version

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1. Introduction

A smart card has to be properly selected, before a data can be exchanged between a reader (system) and the card. This card selection process (card activation) is described in the ISO14443-3 for contactless proximity systems. The dramatic increase in contactless applications has made the correct selection of one single contactless card out of a possible number of cards in the reader field become more and more important. This was foreseen when the ISO standard was developed and therefore the standard describes in detail how the applications need to process them.

1.1 How to use this document

The card selection process can be divided into 2 parts: at first the communication layer describes how to select a single PICC (whatever type of card or application). This is important because the ISO standard, which specifies the contactless smartcard communication, only describes this communication layer, independent of the application. More and more different types of cards and applications can be found in the field, which all use the ISO/IEC 14443.

The second step, after a single card has been selected, is to select the correct application, to handle multiple applications (or cards), or to properly ignore foreign applications (or cards).

Section 2 of this document describes how the ISO/IEC 14443 process to select a single card. The anticollision procedure is mandatory for both type A and type B cards.

In addition to the card activation procedure the system itself has to ensure that the PCD can select the correct application, either with more than one applicationon one single card, or with different applications on different cards. In many systems it is recommended to let the system select the correct application, but not the user, which guarantees a fast and secure transaction. This is shown in section 3.

2. Card activation according to the ISO/IEC14443

The ISO/IEC 14443-3 describes how to select ("activate") a single card. This card activation procedure is generally independent of the number of cards in the field, and of the number of applications:

- This procedure guarantees that a single card is properly selected, independent on the number of cards available in the field during the card activation.

- This procedure guarantees that a single card is properly selected, independent on the number of cards moved into the field during the whole card activation or card transaction.

- This procedure guarantees that a single card keeps being properly selected, independent on the number of cards moved into the field during the whole card activation or card transaction.

Note: For convenience reasons in many contactless systems the cards are continuously moved into the field and then removed from the field. So in such systems it usually cannot be **guaranteed**, that a transaction will be completed. This is not at all related to the card activation procedure or the use of multiple cards in a single reader field.
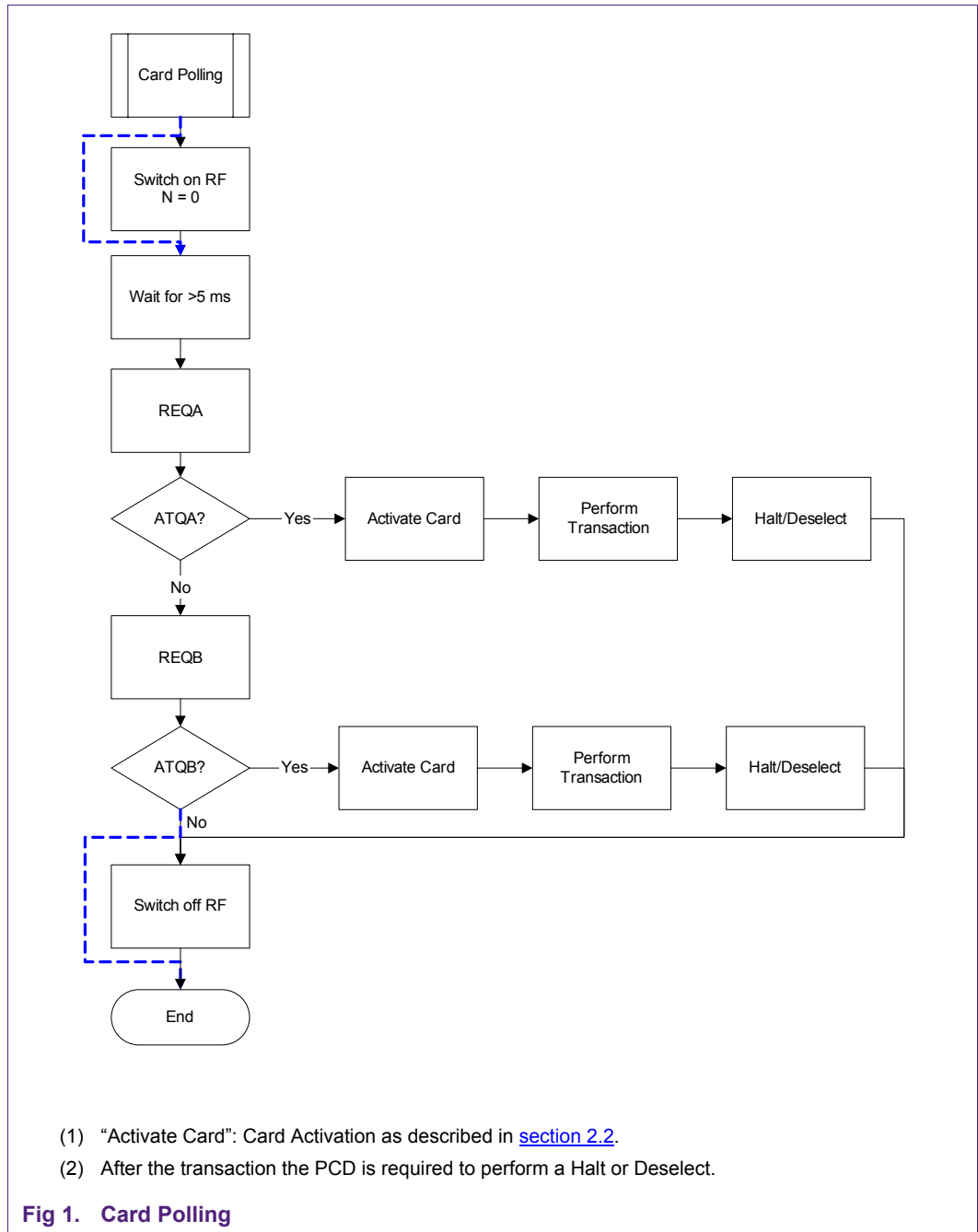
Some additional measures have to be taken into account to **guarantee** the proper function during the whole card transaction: Either a card slot has to be used similarly to the contact card reader slots, or the application (either on the card or in the system) has to offer a recovery procedure (tear protection or back-up management) for those cases, where the transaction can be interrupted.

2.1 Polling for cards

The ISO/IEC 14443 specifies that cards following the ISO/IEC 14443A shall not interfere cards following the ISO/IEC 14443B, and vice versa. In any case the card activation procedure starts with a Request command (REQA or REQB), which is used only to check whether there is at least one card in the reader field. The REQA or REQB has to be send after the carrier is switched on, waiting 5ms at minimum before starting the transmission. This procedure is shown in Fig 1.

Note: The minimum required time between a REQA and REQB or REQB and REQA is 5ms acc. to [8].

Note: For NFC devices there has to be another block between "Card Polling" and "Switch on RF", because NFC devices need to check whether there is already a field available or not. If an external field is detected the reader is not allowed to switch on its own RF field.

(1) "Activate Card": Card Activation as described in section 2.2.

(2) After the transaction the PCD is required to perform a Halt or Deselect.

Fig 1. Card Polling

In some applications it might be required to reset the RF regularly, in some others the carrier is switched on only for a short time anyway. In all casesevery communication starts with a REQA (or REQB). If an ATQA (or ATQB) is received, the "Activate Card" procedure as described in section 2.2 selects the detected card. If no ATQA (or ATQB) is received, the REQB (or REQA) is used.

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If the system requires *only one card with the relevant application* to be allowed in the field, the PCD has to select all relevant cards, and then deselect the ones with foreign applications. The remaining cards with correct applications have to be checked: if more than one of such cards are presented, the PCD has to refuse the transaction. This is not part of the communication layer and is described in section 3.
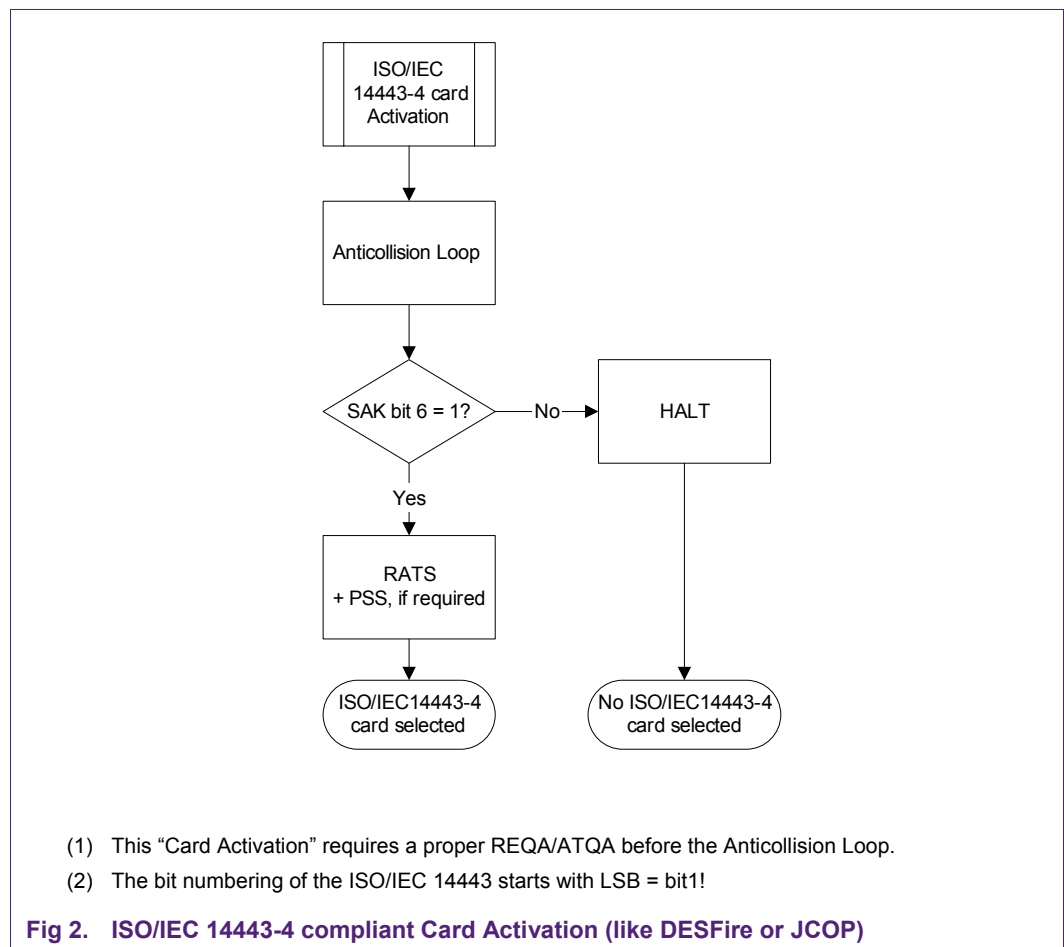
2.2 Activate Card

The Card activation selects a single card, after an ATQA or ATQB has been received.
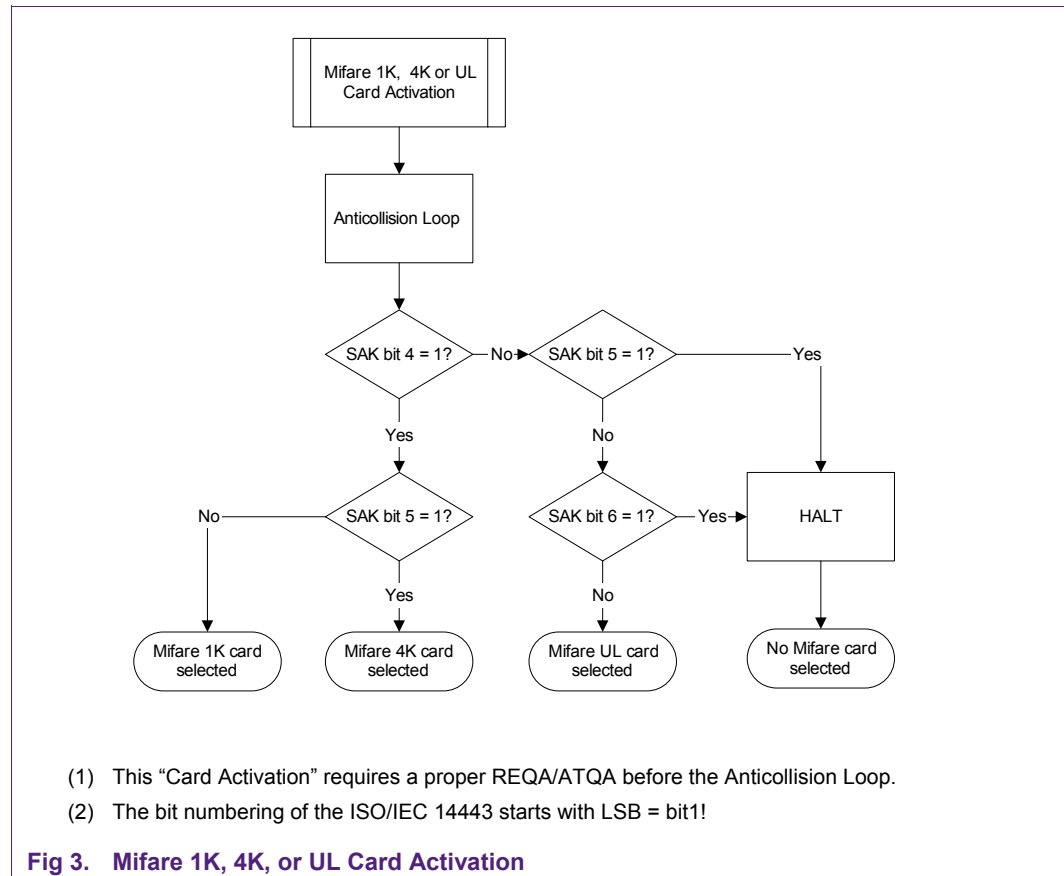
2.2.1 Anticollision procedure acc. ISO/IEC14443A

The Anticollision procedure is mandatory for ISO/IEC 14443A compliant PICCs. All the NXP Mifare products support the anticolllision according to ISO/IEC14443 A.

The "Activate Card" includes the Anticollision and Card selection of a single card (for both type A or type B). For ISO/IEC 14443-4 compliant PICCs (like Mifare DESFire, cards for contactless payment, electronic passports, etc.) the Activate Card includes the proper setup of the transmission protocol as shown in Fig 2.

(1) This "Card Activation" requires a proper REQA/ATQA before the Anticollision Loop.

(2) The bit numbering of the ISO/IEC 14443 starts with LSB = bit1!

Fig 2. ISO/IEC 14443-4 compliant Card Activation (like DESFire or JCOP)

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According to the SAK coding the Mifare cards like Mifare 1K, Mifare 4K or Mifare Ultralight can be clearly separated and selected as shown in Fig 3.

(1) This "Card Activation" requires a proper REQA/ATQA before the Anticollision Loop.

(2) The bit numbering of the ISO/IEC 14443 starts with LSB = bit1!

Fig 3. Mifare 1K, 4K, or UL Card Activation

Note: It is not recommended to use the ATQA to determine card parameters due to possible collisions.

2.2.2 Anticollision procedure acc. ISO/IEC14443B

For coding the REQB command (and all other ISO/IEC 14443 B commands) the "Mf500PiccExchangeBlock" (refer to [10]) together with the MF RC531 or CL RC632 can be used, if

- all the relevant reader IC **registers are set correctly** for ISO/IEC 14443 B communication (refer to [6] or [7]), and

- the **CRC is coded correctly**. The CRC Enable / Disable functionality of "Mf500PiccExchangeBlock " of the original Basic Function Library ([10]) overwrites the ISO/IEC 14443 B settings in the ChannelRedundancy register. Instead of overwriting the complete 8 bit of the register, only the RxCRCEn and TxCRCEn should be masked and set or reset, without changing the rest of that register.

If an ATQB is received with communication errors, the anticollision procedure according to [8] has to solve the collisions, and select one single card.

The Card Activation uses ATQB and the ATTRIB command including answer to establish the protocol layer of the ISO/ IEC 14443 for an ISO/IEC 14443 B compliant card.

Note: For more details and IP related issues regarding Type B check [8].

3. Selecting the correct application

Due to the fact, that in a standard system there can be more than one PICC in the active PCD field, the system has to select the right one – and has to deselect all the other ones.

In any case the system has to be able to separate cards with foreign applications from card with the own application – and properly exclude the "foreign card" from the own selection process. The system has to be able to exclude cards containing foreign applications especially in those cases, where the system requires the operation being limited to "**one single card"**.

Note: This selection process is related to the application, but not to the communication!

The principle of this selection is always the same: every card in the field is selected andqueried to check if it contains the relevant application or not. If more than one card in the field contains the relevant application, the system either has to prioritize the cards or refuse the transaction.

If only one card contains the relevant application, the system has to perform the transaction – independent of the number of cards in the field.

The following sections describe how to properly select the relevant application, if only one type of cards is used in the system (e.g. Mifare Standard only). However, the process can of course be extended to operate applications using different type of cards, too.
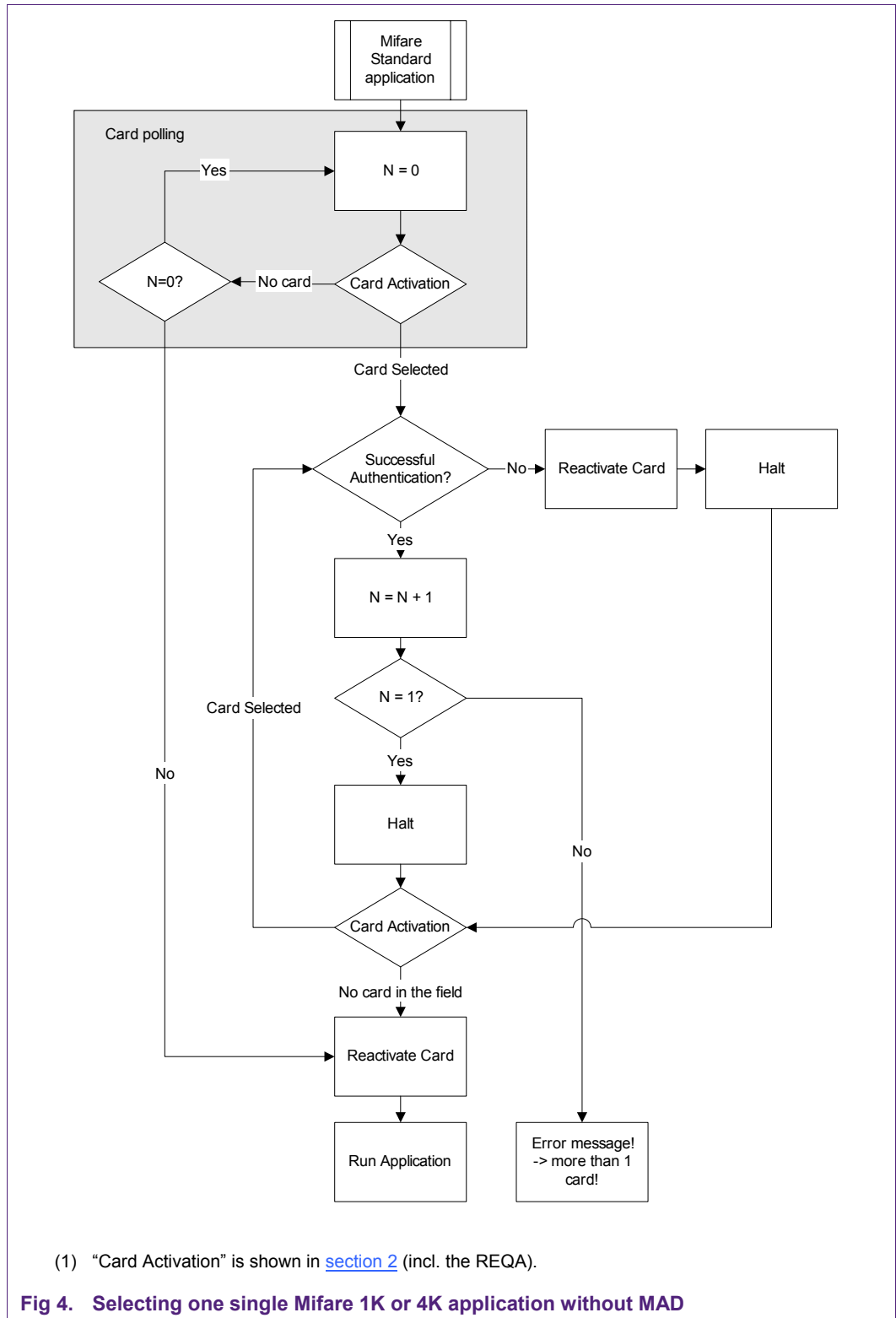
3.1 Selecting a Mifare standard application

In many cases the system needs to select one Mifare standard card (like Mifare 1K or Mifare 4K or Mifare Ultralight). In all those cases the PCD does not use the transmission protocol, but just selects the card according to ISO/IEC 14443-3. Afterwards the application runs the application related commands (like the Authentication for the Mifare 1K or Mifare 4K or Read for the Mifare Ultralight).
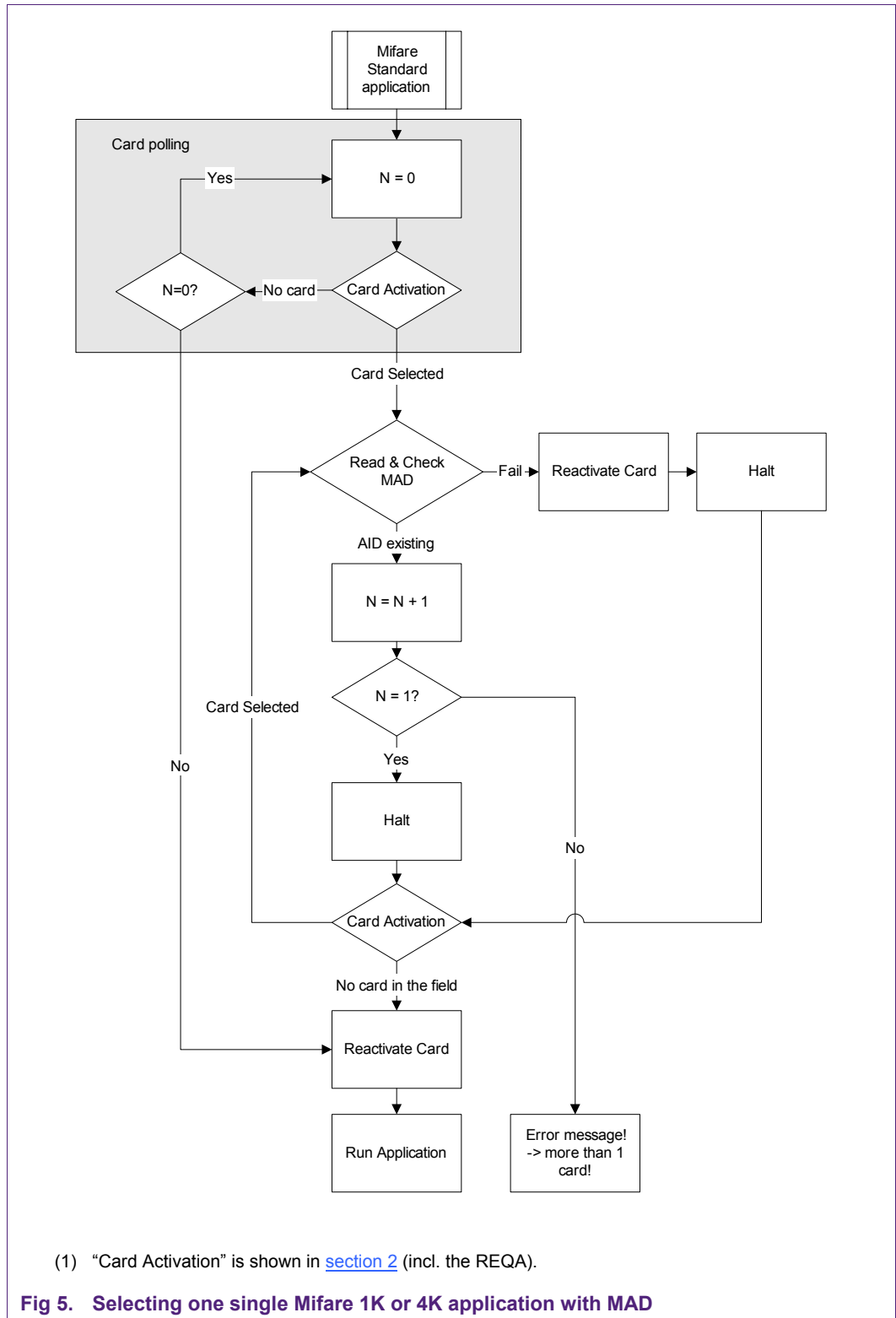
The process for selecting a Mifare 1K or 4K as shown in Fig 4 (without MAD) or Fig 5 (using MAD) uses the Activate Card without activating the transmission protocol. Every ISO/IEC14443-4 compliant card is selected and properly halted in this process. A dual interface card providing both a Mifare Emulation as well as an ISO/IEC14443-4 protocol layer is automatically correctly activated as a Mifare standard card here.

This process returns an error if more then one Mifare standard card with the relevant application is in the field.

"Reactivate Card" uses the WUPA, and the Select command.

Note: The same process as shown in Fig 4 can be used for the Mifare Ultralight, if a Read command instead of the Authentication is used.

(1) "Card Activation" is shown in section 2 (incl. the REQA).

Fig 4.   Selecting one single Mifare 1K or 4K application without MAD

(1) "Card Activation" is shown in <u>section 2</u> (incl. the REQA).

Fig 5.   Selecting one single Mifare 1K or 4K application with MAD

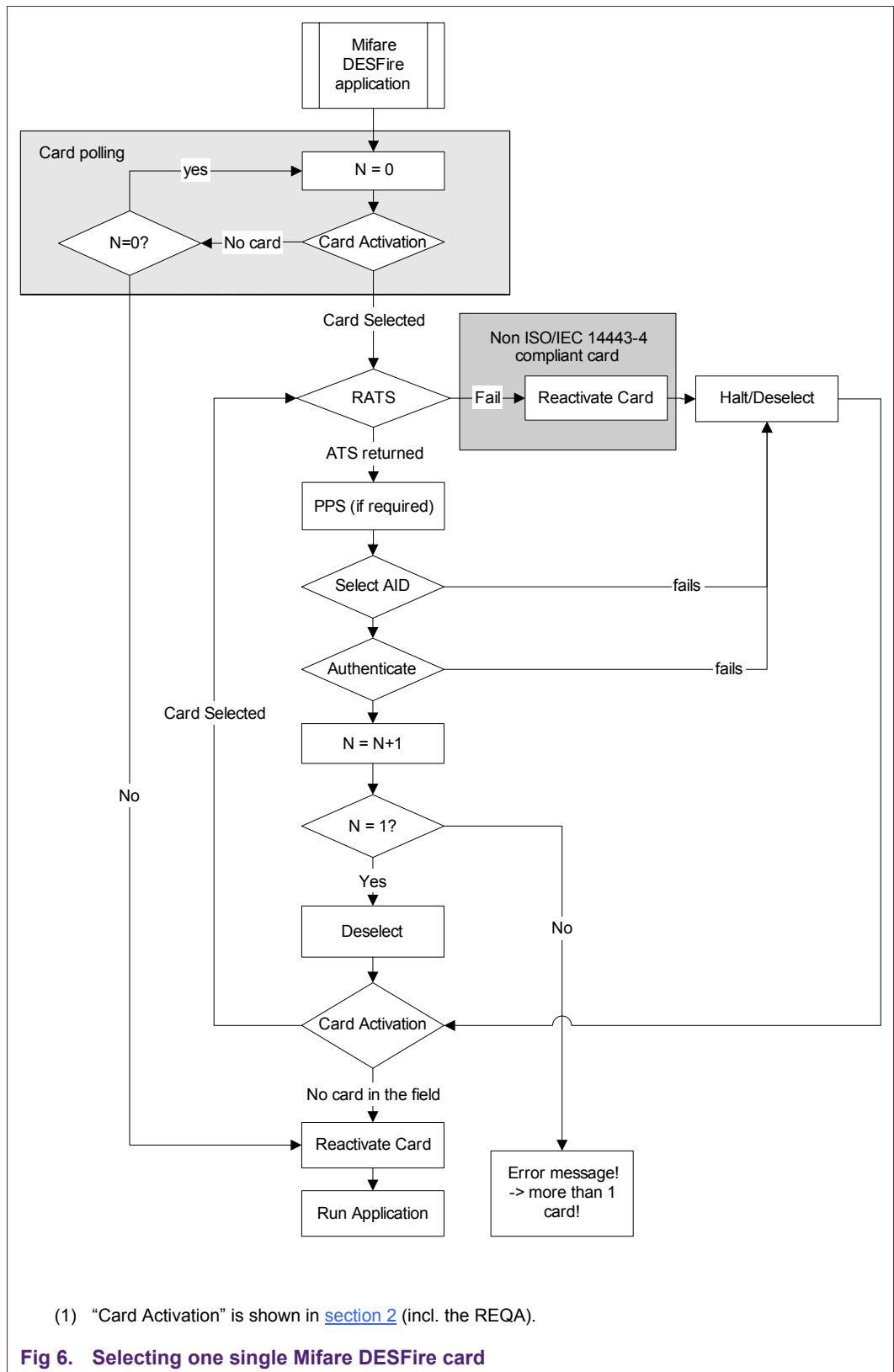## 3.2 Selecting an ISO14443-4 compliant application

In many applications using ISO/IEC 14443-4 compliant cards the proper selection of one card out of a number of cards is required. Even if the transaction requires more than one card to be addressed, usually every system uses a transaction flow which addresses cards sequentially. So every card should be activated (and deactivated) separately, even though the ISO/IEC 14443 protocol activation allows the use of CIDs and several cards in parallel.

Note: For better communication stability it is recommended to only activate and select the card that is being used in the current transaction, if not otherwise required.

Fig 6 shows the selection of an application on a DESFire card as an example. Every other card that does not contain the relevant application is ignored from the system (i.e. properly deselected). If more than one DESFire card with such a relevant application is presented to the reader, the systems refuses the transaction.

"Reactivate Card" uses the WUPA, and the Select command.

The same principle can be used to select other applications on other type of cards, e.g. a payment application on a JCOP card or a electronic passport application on an eMRTD.

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(1) "Card Activation" is shown in section 2 (incl. the REQA).

Fig 6. Selecting one single Mifare DESFire card

3.3 Using multiple cards during one transaction

In some cases the system might require to handle two ore more cards in parallel during the same transaction. In such a case the system can use the CID of the protocol to activate and address each card during one transaction.

The selection process is the same as shown in Fig 6, and can be processed as many times as cards are in the field, using different CIDs to select each card.

4. Terms and Abbreviations

Table 1.   Abbreviations

Acronym	Description
application	here: the application on the card
ATQA	Answer To reQuest type A (refer to [8])
ATQB	Answer To reQuest type B (refer to [8])
ATTRIB	PICC Selection command ISO/IEC 14443 B (refer to [8])
card	here: PICC acc. to the ISO/IEC 14443 (contactless proximity smart card)
CID	Card IDentifier (refer to [8])
eMRTD	electronic Machine Readable Travel Document ("ICAO compliant ePassport")
ICAO	International Civil Aviation Organization
MAD	mifare Multi Application Directory (refer to [12])
NFC	Near Field Communication
PCD	Proximity Coupling Device ("Reader")
PPS	Protocol Parameter Selection (refer to [8])
RATS	Request for Answer To Select (refer to [8])
reader	here: PCD acc. to the ISO/IEC 14443 (refer to [8])
SAK	Select AcKnowledge (refer to [8])
system	here: the system application

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5. References

[1] Mifare[®] (14443A) 13,56 MHz RFID Proximity Antennas; Application Note

[2] ISO/IEC 14443 higher bit rates with Micore; Application Note

[3] Data Sheet; SL RC400 I Code Reader IC

[4] MIFARE[®] MF RC500; Highly Integrated ISO 14443A Reader IC

[5] MIFARE[®] MF RC 530 ISO14443A reader IC

[6] MIFARE[®] MF RC531; ISO 14443 Reader IC

[7] MIFARE[®] and I Code CL RC632 Multiple protocol contactless reader IC

[8] ISO/IEC14443 Identification cards - Contactless integrated circuit(s) cards - Proximity cards

[9] ISO10373-6 Identification cards — Test methods part 6: Proximity cards

[10] Sample Source Code, Basic Function Library MF RC5xx

[11] MIFARE[®] Interface Platform Type Identification Procedure

[12] MIFARE Application Directory MAD

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7. Index

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