

# AN10834

## MIFARE ISO/IEC 14443 PICC selection

Rev. 4.2 — 10 August 2021

Application note  
COMPANY PUBLIC

### Document information

Information	Content
Keywords	Activate card, MIFARE, MIFARE 2GO, virtual card, 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.



## Revision history

### Revision history

Rev	Date	Description
4.2	20210810	<ul style="list-style-type: none"><li>• Moved the product distinction flowchart to "AN10833 - MIFARE type identification procedure" (see <a href="#">[4]</a>)</li><li>• Minor editorial changes</li><li>• Added references to documents related with MIFARE 2GO</li></ul>
4.1	20200320	General update and inclusion of latest product generations
4.0	20170208	General update
3.0	20090626	Third version. Correction of wording.
2.0	20090518	Second version (supersedes AN130810 MIFARE ISO/IEC 14443 PICC Selection, Rev. 1.0, 17 October 2006)

## 1 Introduction

---

A smart card has to be properly selected, before 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 important. This was foreseen when the ISO standard was developed and therefore the standard describes in detail how the applications must 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 smart card 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 anti-collision 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 application on 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](#).

In this document, the term „MIFARE card“ refers to a contactless card using an IC out of the MIFARE Classic, MIFARE Ultralight, MIFARE Plus or MIFARE DESFire product family.

## 2 Card activation according to ISO/IEC 14443

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.

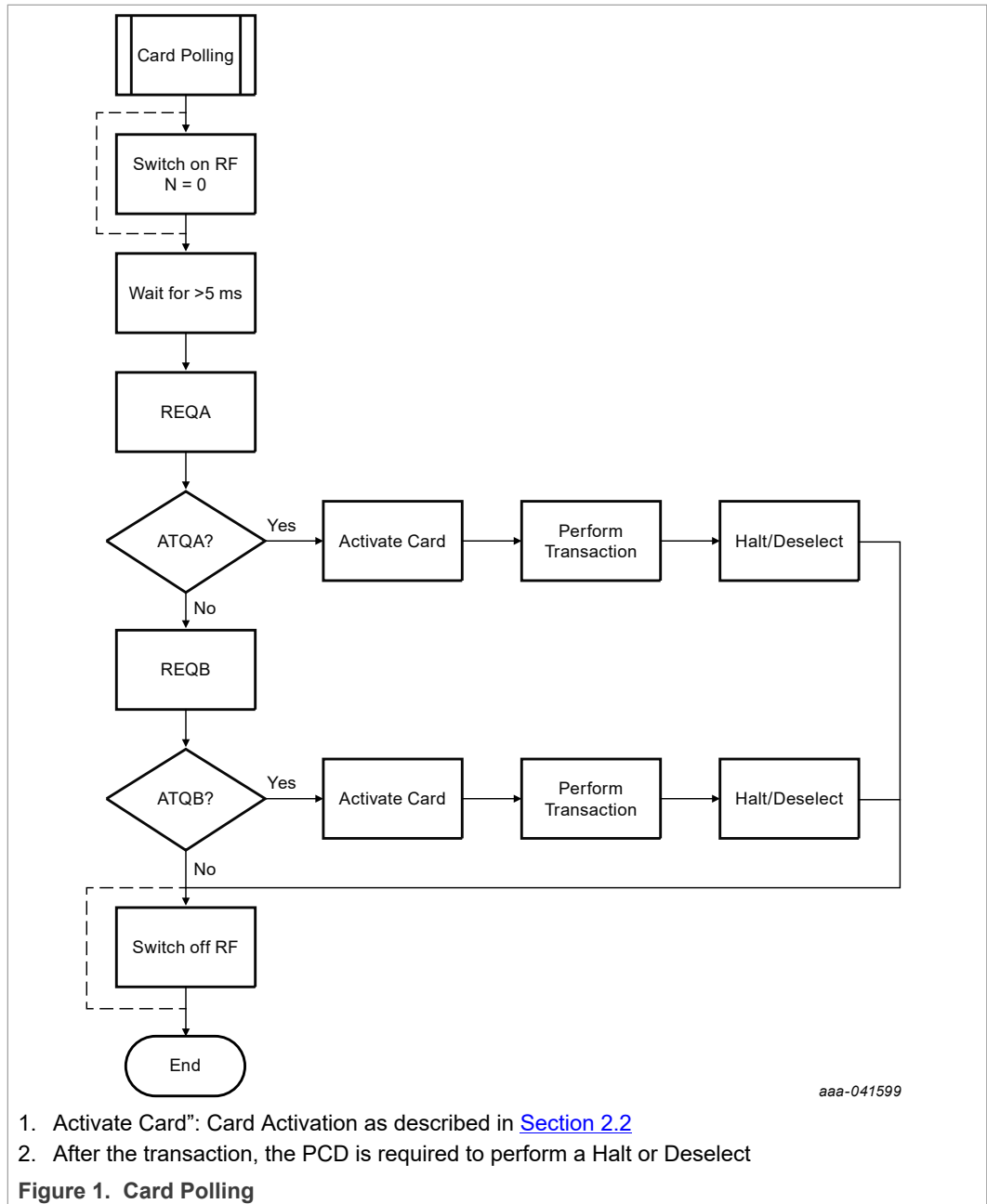
Some additional measures have to be taken into account to **guarantee** the proper function during the whole card transaction: Either a card slot has to be used similarly to the contact card reader slots, or the application (either on the card or in the system) has to offer a recovery procedure (tear 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 sent after the carrier is switched on, waiting 5 ms at minimum before starting the transmission. This procedure is shown in [Figure 1](#).

**Note:** The minimum required time between a REQA and REQB or REQB and REQA is 5 ms.

**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.



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 cases, every 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.

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. Then deselect the ones with foreign applications. The remaining cards with correct applications have to be checked: if more than one of such cards is presented, the PCD has to refuse the transaction. This is not part of the communication layer and is described in [Section 3](#).

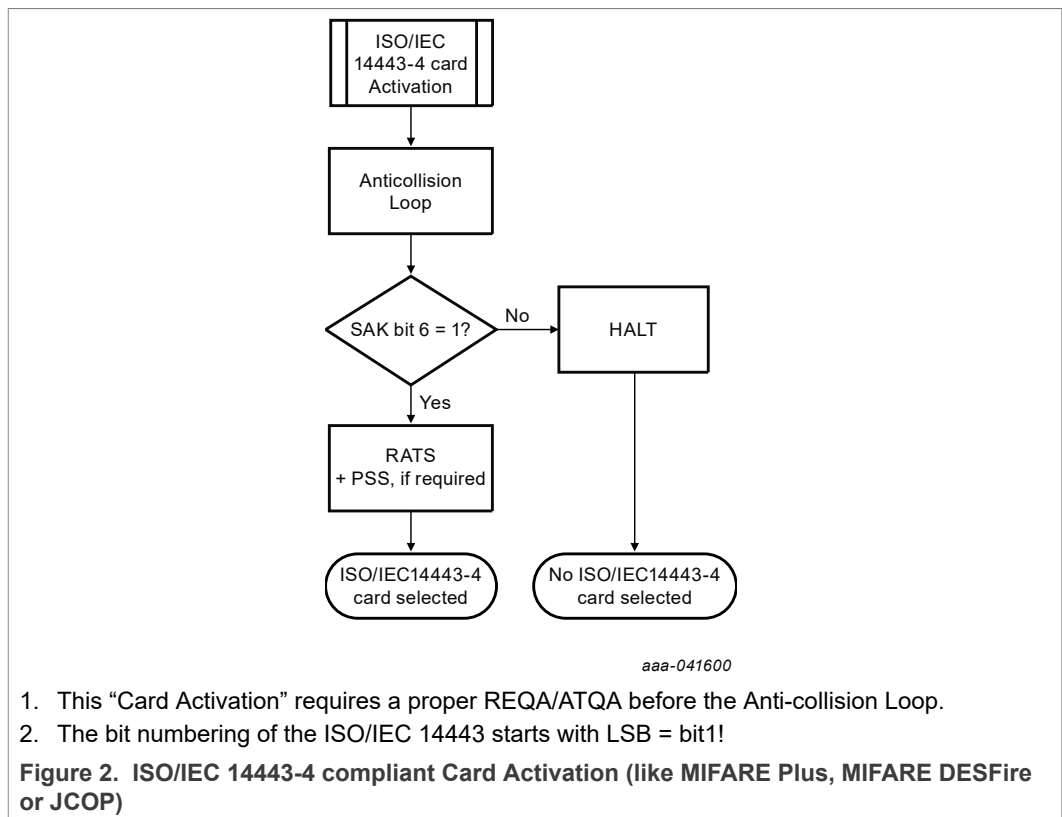
## 2.2 Activate card

The card activation selects a single card, after an ATQA.

### 2.2.1 Anti-collision procedure acc. ISO/IEC 14443A

The anti-collision procedure is mandatory for ISO/IEC 14443A compliant PICCs. All the NXP MIFARE products support the anti-collision according to ISO/IEC14443 A.

The “Activate Card” includes the anti-collision 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 [Figure 2](#).



### 3 Selecting the correct application

Due to the fact, that in a standard system 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 and queried 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 product only). However, the process can of course be extended to operate applications using different type of cards, too.

#### 3.1 Selecting a MIFARE product application

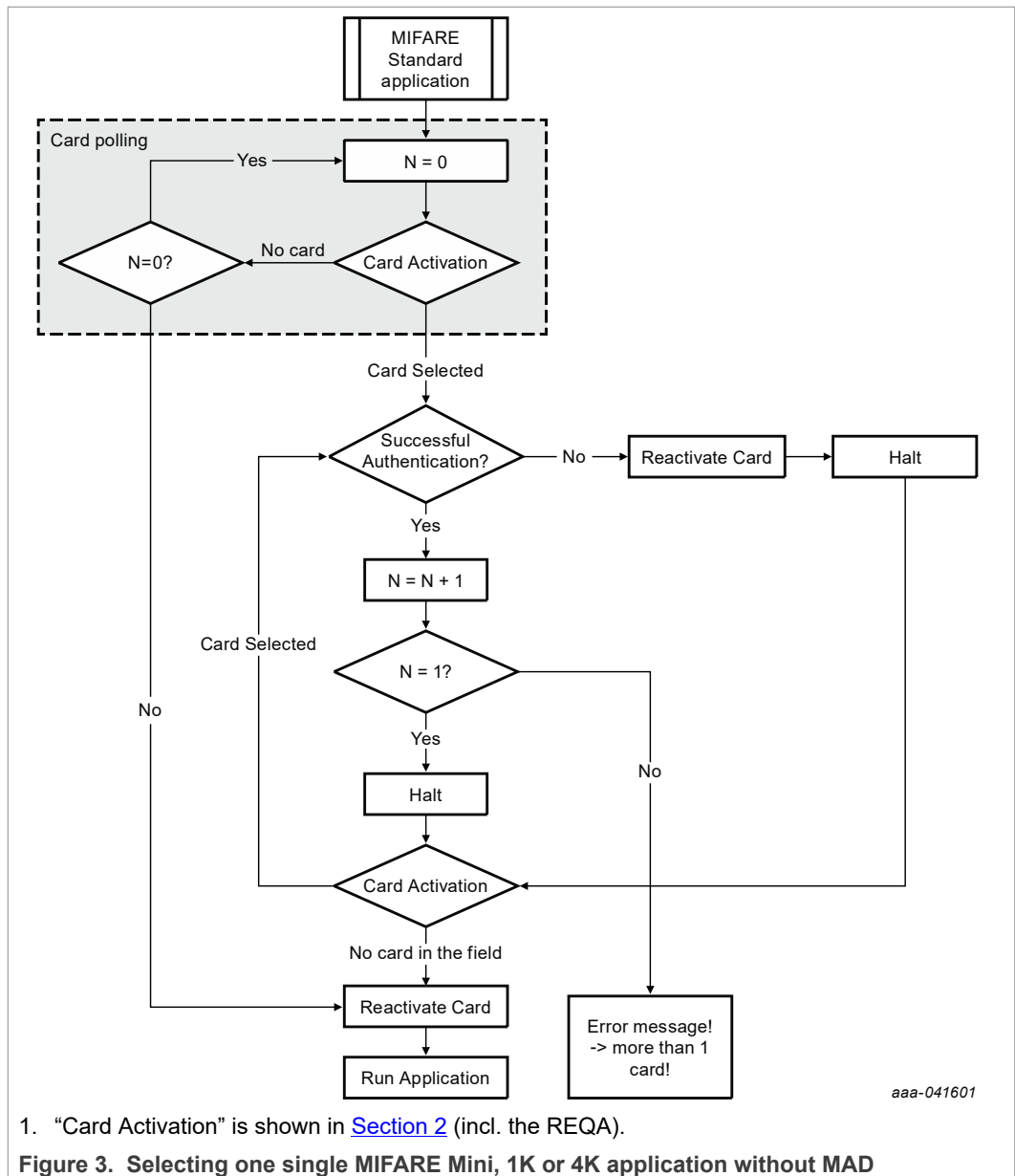
In many cases, the system needs to select one MIFARE product card (like MIFARE Classic 1K or MIFARE Classic 4K or MIFARE Ultralight). In all those cases the PCD does not use the transmission protocol, but just selects the card according to ISO/IEC 14443-3. Afterwards the application runs the application-related commands (like the Authentication for the MIFARE Classic 1K or MIFARE Classic 4K or Read for the MIFARE Ultralight).

The process for selecting a MIFARE Classic 1K or MIFARE Classic 4K as shown in [Figure 3](#) (without MAD) or [Figure 4](#) (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 product card here.

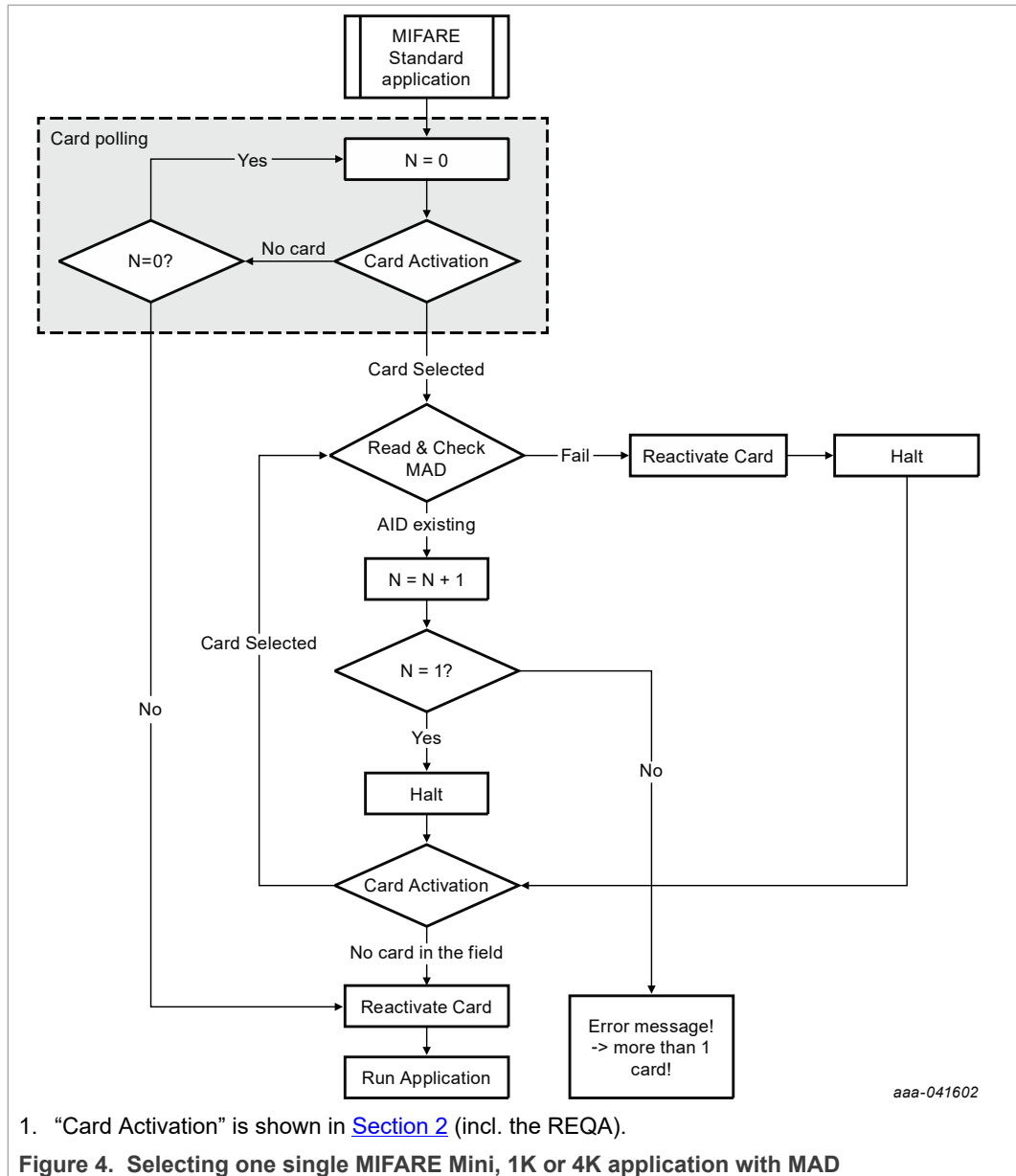
This process returns an error if more than one MIFARE product card with the relevant application is in the field.

“Reactivate Card” uses the WUPA, and the Select command.

**Note:** The same process as shown in [Figure 3](#) can be used for MIFARE Ultralight versions, if a Read command instead of the Authentication is used.







### 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.

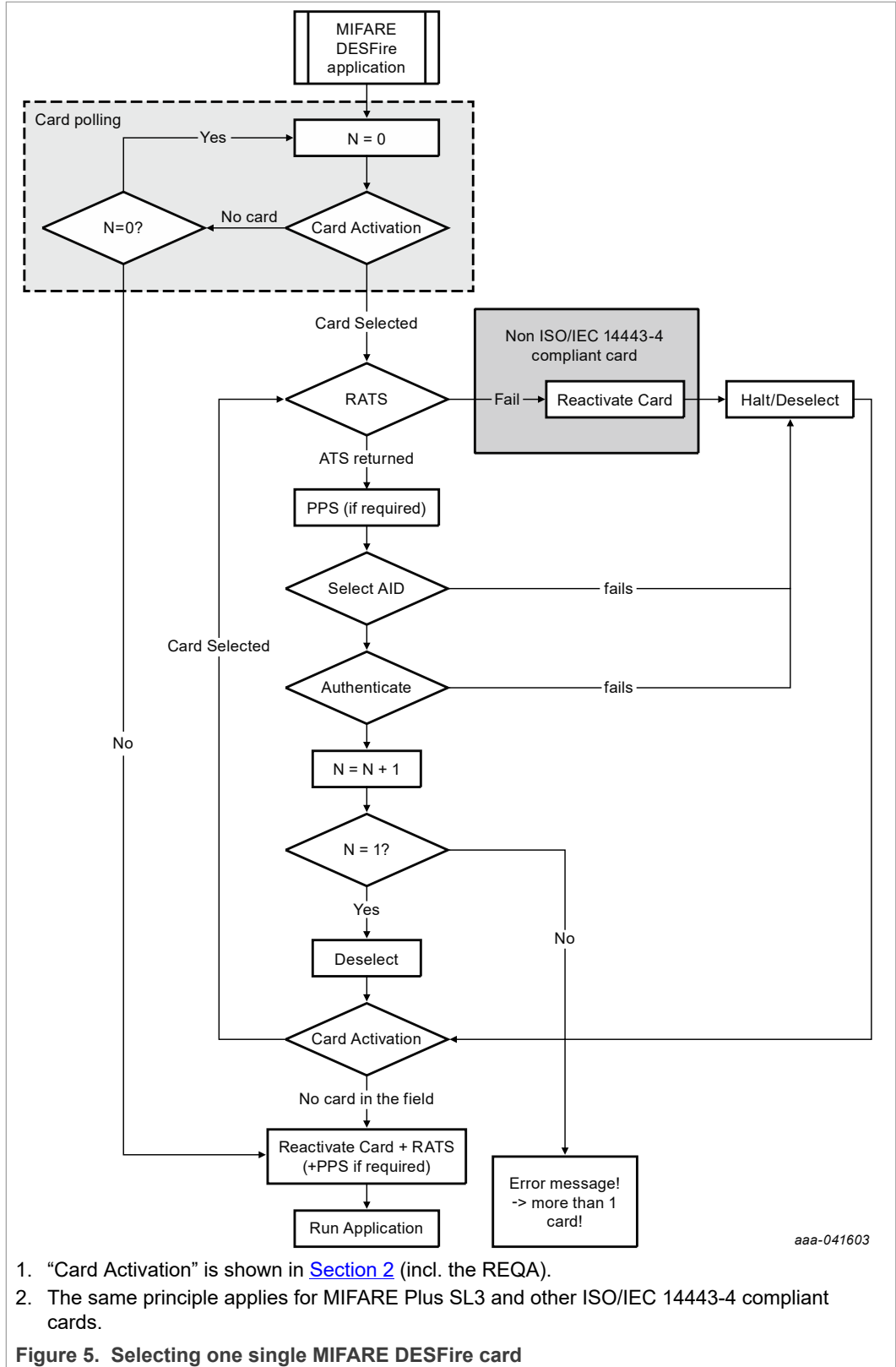
**Note:** For better communication stability, it is recommended to only activate and select the card that is being used in the current transaction, if not otherwise required.

[Figure 5](#) 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 system 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 ticketing application on a MIFARE Plus SL3 card, a payment application on a JCOP card or an electronic passport application on an eMRTD, or a digital MIFARE card on a Smartphone, using ISOSelect.



### 3.3 Using multiple cards during one transaction

In some cases, the system might require to handle two or 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 [Figure 5](#), and can be processed as many times as cards are in the field, using different CIDs to select each card.

### 3.4 Detection of MIFARE products

Detailed information on how to detect which MIFARE product is presented to a reader can be found in [\[4\]](#).

If systems are targeted to work with MIFARE products as well as MIFARE 2GO, all relevant information on how to design the application selection can be found in [\[5\]](#) and [\[6\]](#).

## 4 Terms and Abbreviations

**Table 1. Abbreviations**

Acronym	Description
Application	Here: the application on the card
ATQA	Answer To re-Quest type A
ATQB	Answer To re-Quest type B
Card	Here: PICC acc. to the ISO/IEC 14443 (contactless proximity smart card)
CID	Card Identifier
eMRTD	electronic Machine-Readable Travel Document ("ICAO-compliant ePassport")
ICAO	International Civil Aviation Organization
MAD	MIFARE Multi Application Directory
NFC	Near Field Communication
PCD	Proximity Coupling Device ("Reader")
PPS	Protocol Parameter Selection
RATS	Request for Answer To Select
Reader	Here: PCD acc. to the ISO/IEC 14443
SL	MIFARE Plus Security Level (0, 1, 2 or 3)
SAK	Select Acknowledge
System	Here: the system application

## 5 References

---

1. **ISO/IEC14443 Identification cards** – Contactless integrated circuit(s) cards – Proximity cards
2. **ISO10373-6 Identification cards** – Test methods part 6: Proximity cards
3. **AN10787 MIFARE Application Directory (MAD)** - available on nxp.com, <https://www.nxp.com/docs/en/application-note/AN10787.pdf>
4. **AN10833 - MIFARE type identification procedure** - available on nxp.com, <https://www.nxp.com/docs/en/application-note/AN10833.pdf>
5. **AN12057 - Making reader infrastructures ready for multi-application cards and devices** - available on nxp.com, <https://www.nxp.com/docs/en/application-note/AN12057.pdf>
6. **AN4513 - Reader infrastructure requirements to support risk managed MIFARE2GO software solution** - available on DocStore

## 6 Legal information

### 6.1 Definitions

**Draft** — A draft status on a document indicates that the content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included in a draft version of a document and shall have no liability for the consequences of use of such information.

### 6.2 Disclaimers

**Limited warranty and liability** — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors. In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory. Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms and conditions of commercial sale of NXP Semiconductors.

**Right to make changes** — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

**Suitability for use** — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

**Applications** — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification. Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products. NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

**Terms and conditions of commercial sale** — NXP Semiconductors products are sold subject to the general terms and conditions of commercial

sale, as published at <http://www.nxp.com/profile/terms>, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

**Export control** — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

**Evaluation products** — This product is provided on an "as is" and "with all faults" basis for evaluation purposes only. NXP Semiconductors, its affiliates and their suppliers expressly disclaim all warranties, whether express, implied or statutory, including but not limited to the implied warranties of non-infringement, merchantability and fitness for a particular purpose. The entire risk as to the quality, or arising out of the use or performance, of this product remains with customer. In no event shall NXP Semiconductors, its affiliates or their suppliers be liable to customer for any special, indirect, consequential, punitive or incidental damages (including without limitation damages for loss of business, business interruption, loss of use, loss of data or information, and the like) arising out of the use of or inability to use the product, whether or not based on tort (including negligence), strict liability, breach of contract, breach of warranty or any other theory, even if advised of the possibility of such damages. Notwithstanding any damages that customer might incur for any reason whatsoever (including without limitation, all damages referenced above and all direct or general damages), the entire liability of NXP Semiconductors, its affiliates and their suppliers and customer's exclusive remedy for all of the foregoing shall be limited to actual damages incurred by customer based on reasonable reliance up to the greater of the amount actually paid by customer for the product or five dollars (US\$5.00). The foregoing limitations, exclusions and disclaimers shall apply to the maximum extent permitted by applicable law, even if any remedy fails of its essential purpose.

**Translations** — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

**Security** — Customer understands that all NXP products may be subject to unidentified or documented vulnerabilities. Customer is responsible for the design and operation of its applications and products throughout their lifecycles to reduce the effect of these vulnerabilities on customer's applications and products. Customer's responsibility also extends to other open and/or proprietary technologies supported by NXP products for use in customer's applications. NXP accepts no liability for any vulnerability. Customer should regularly check security updates from NXP and follow up appropriately. Customer shall select products with security features that best meet rules, regulations, and standards of the intended application and make the ultimate design decisions regarding its products and is solely responsible for compliance with all legal, regulatory, and security related requirements concerning its products, regardless of any information or support that may be provided by NXP. NXP has a Product Security Incident Response Team (PSIRT) (reachable at [PSIRT@nxp.com](mailto:PSIRT@nxp.com)) that manages the investigation, reporting, and solution release to security vulnerabilities of NXP products.

### 6.3 Licenses

#### ICs with DPA Countermeasures functionality



NXP ICs containing functionality implementing countermeasures to Differential Power Analysis and Simple Power Analysis are produced and sold under applicable license from Cryptography Research, Inc.

## 6.4 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

**MIFARE** — is a trademark of NXP B.V.

**DESFire** — is a trademark of NXP B.V.

**MIFARE Plus** — is a trademark of NXP B.V.

**MIFARE Ultralight** — is a trademark of NXP B.V.

**JCOP** — is a trademark of NXP B.V.

**MIFARE Classic** — is a trademark of NXP B.V.



**Tables**

Tab. 1. Abbreviations ..... 13

## Figures

Fig. 1.	Card Polling .....	5	Fig. 3.	Selecting one single MIFARE Mini, 1K or 4K application without MAD .....	8
Fig. 2.	ISO/IEC 14443-4 compliant Card Activation (like MIFARE Plus, MIFARE DESFire or JCOP) .....	6	Fig. 4.	Selecting one single MIFARE Mini, 1K or 4K application with MAD .....	9
			Fig. 5.	Selecting one single MIFARE DESFire card ....	11

---

## Contents

---

<b>1</b>	<b>Introduction .....</b>	<b>3</b>
1.1	How to use this document .....	3
<b>2</b>	<b>Card activation according to ISO/IEC 14443 .....</b>	<b>4</b>
2.1	Polling for cards .....	4
2.2	Activate card .....	6
2.2.1	Anti-collision procedure acc. ISO/IEC 14443A .....	6
<b>3</b>	<b>Selecting the correct application .....</b>	<b>7</b>
3.1	Selecting a MIFARE product application .....	7
3.2	Selecting an ISO14443-4 compliant application .....	9
3.3	Using multiple cards during one transaction ....	12
3.4	Detection of MIFARE products .....	12
<b>4</b>	<b>Terms and Abbreviations .....</b>	<b>13</b>
<b>5</b>	<b>References .....</b>	<b>14</b>
<b>6</b>	<b>Legal information .....</b>	<b>15</b>

---

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

---

© NXP B.V. 2021.

All rights reserved.

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

Date of release: 10 August 2021  
Document identifier: AN10834