

# AN10992

## Quick Startup Guide for RD710

Rev. 2.4 — 08 October 2012  
198124

Application note  
COMPANY PUBLIC

### Document information

Info	Content
<b>Keywords</b>	RD710, Quick startup guide, SAM AV1, SAM AV2, RC523.
<b>Abstract</b>	This document is intended for new users to start working with the Design-In Kit. It shows the basic functionality with MIFAREdiscover.



**Revision history**

Rev	Date	Description
2.4	20121008	Examples add and MIFARE discover explanation updated
2.3	20120807	Updated firmware info
2.2	20120710	FCC disclaimer, driver installer, Pegoda2Go, firmware info added, demo mode changed, outdated types removed, ISO replaced with ISO/IEC
2.1	20111206	Added in 5.1 the Activation of a MIFARE Classic Card.
2.0	20110803	Extended usecases for MIFAREdiscover
1.1	20110712	Update due to release of new usecases of MIFAREdiscover
1.0	20110411	Initial version
	20110105	Draft version

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## 1. Introduction

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The purpose of this document is to provide a set of guidelines to aid in the first operation of the RD710 reader. The MIFAREdiscover (ver.3.x.x) will be used as a user interface to communicate to the readers and cards, respectively.

The USB drivers are included in the CD package and on NXP web (see [44])

### 1.1 Firmware Info

This package comes with a new firmware (version 2.2.7) for the RD710 reader. In this version the NXP Basic Function Library (BFL) is replaced by the NXP Reader Library (NXPRdLib). The functionality of the PC/SC mode has not been changed. The PC Software using the Reader in this mode (e.g. MIFAREDiscover) will not face any functional differences.

#### 1.1.1 Additional functionality and benefits of Firmware v2.2.7 in standalone mode

- Support of ISO/IEC 14443 Type B Tags
- Improved multi Tag handling
- Improved code structure and modular library design for easier development
- Improved LPCXpresso Support

For further information about the actual implementation please refer to [38].

#### 1.1.2 Firmware version installed on the Reader

If you have received the reader together with this document version on CD it already contains the latest firmware. You can check this with the program Pegoda2Go which is as well in the CD package. If you have already installed the driver you can start Pegoda2Go as described in section 2.5 and check the current flashed version. Otherwise you have to install the drivers first.

#### 1.1.3 Update Recommendation:

For new projects and implementations the usage of the latest firmware and source code is recommended. This is as well the case for projects using the reader in PC/SC mode only.

As the NXPRdLib has a different software design compared to the BFL, porting of existing projects based on the former firmware will require major rework and is not recommended unless one needs to take advantage of the additional functionality and benefits.

If you want to flash to the latest version proceed as described in section 8. Therefore the latest binary file is located on the CD and on NXP web [42].

(Reader documentation\Cortex M3 \firmware\_v2\_2\pegoda\_fw\_v2\_2.bin).

## 2. Installation

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### 2.1 Required items

To use the MIFAREdiscover, the following items are required:

- MIFARE cards as MIFARE DESFire EV1, MIFARE Classic, MIFARE Ultralight
- Pegoda Reader (RD710 or RD710 as part of EV710) (see [37]– [41])
- MIFAREdiscover
  - Public version available on NXP web (see [45])
  - Full version (see [47])

### 2.2 Installing USB driver for the Reader

An installer for the USB drive is present on the CD (Driver\ Windows Driver Installer.exe).

- 1) Run this installer and follow the displayed instructions.
- 2) Connect the Pegoda RD710 with your computer.
- 3) Wait until Windows has installed the driver.

If Windows installs the drives correctly you can skip section 2.3 and continue with section 2.4.

### 2.3 Installing USB driver for the Reader manually

The demonstrated installation is shown on Windows 7, but it is the same in Windows XP and Vista.

- 4) If you don't have a CD that was delivered with your Pegoda, open your web browser, go to see [44] and download and extract the zip file.
- 5) Connect the Pegoda RD710 with your computer.
- 6) Wait until Windows 7 installs a standard driver.
- 7) Open the Windows Device Manager and navigate to the installed Reader (see figure 1 below)

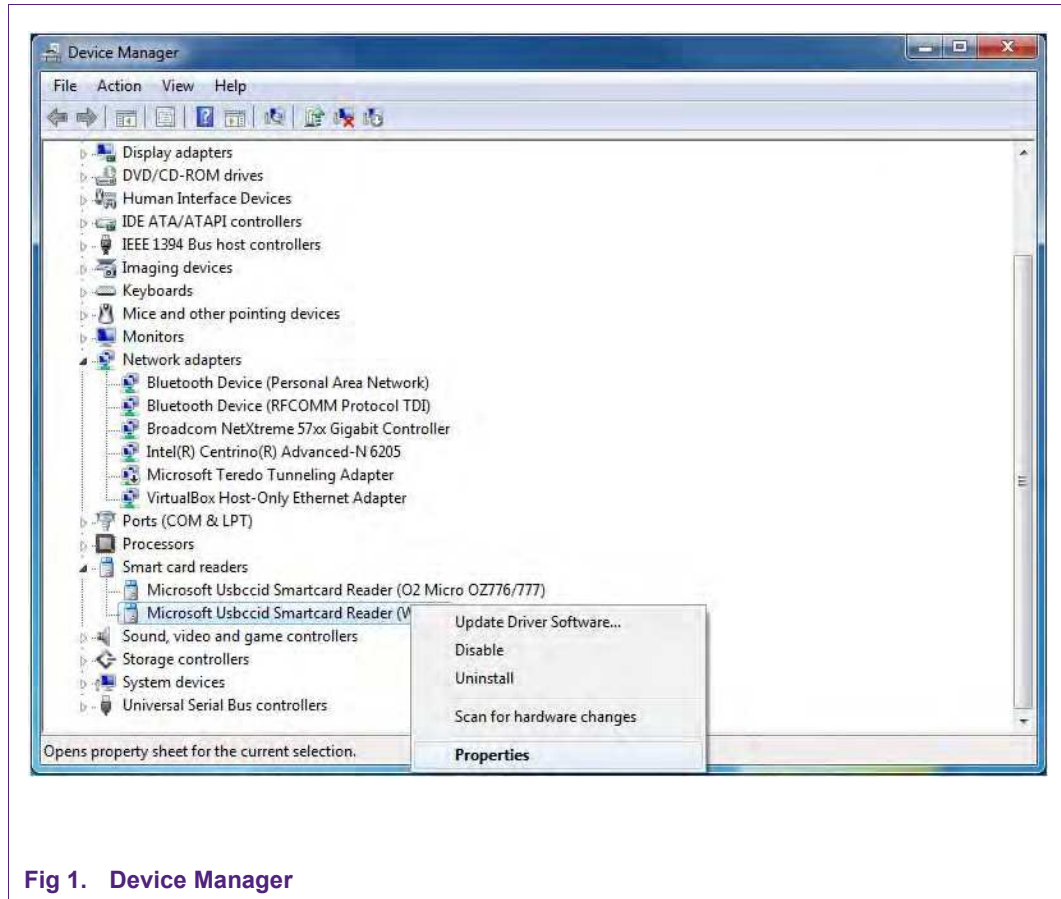


Fig 1. Device Manager

- 8) Click Smartcard Reader with the right mouse button and choose “Properties”.
- 9) Choose the tab driver and click “Update Driver”.

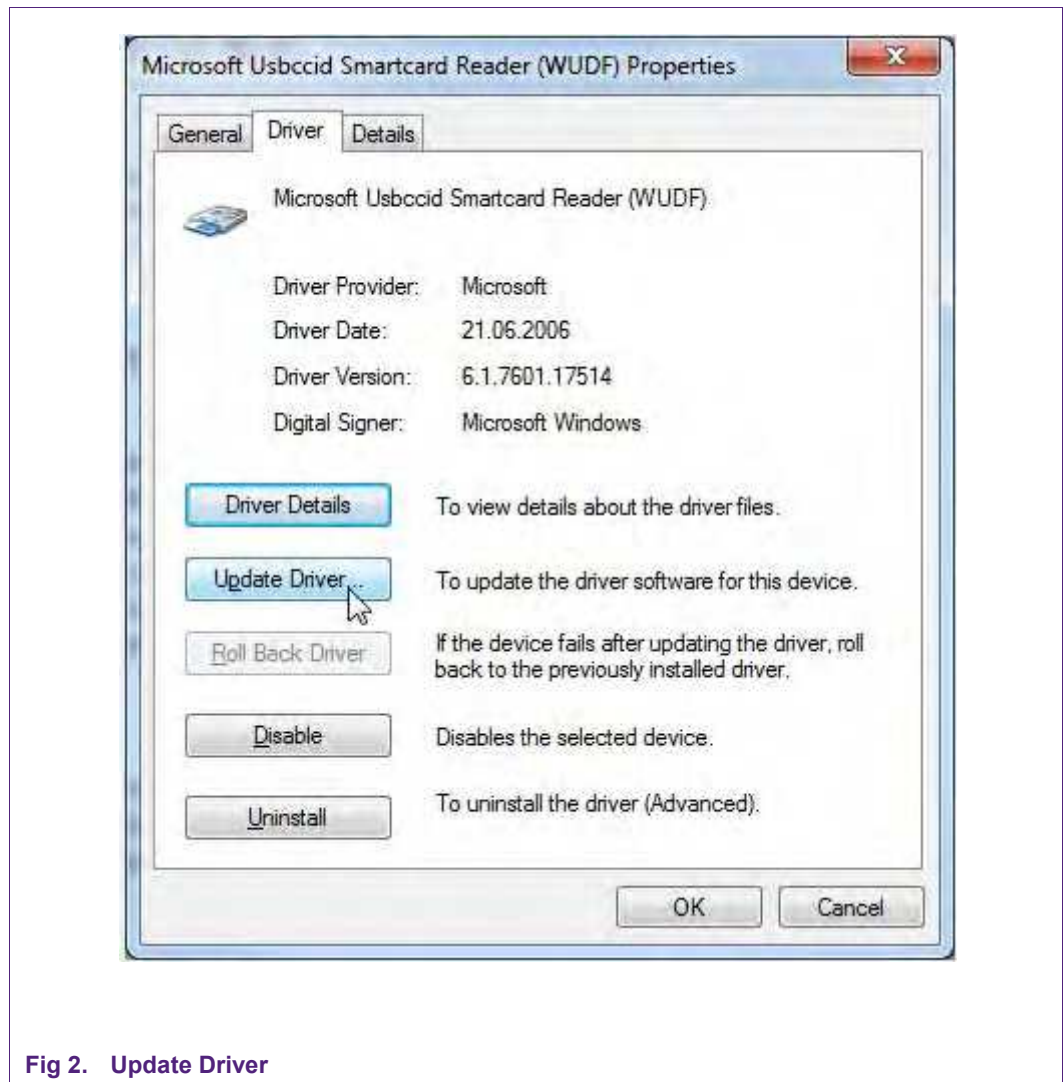


Fig 2. Update Driver

10) Windows will ask you how to search for the driver. Choose "Browse my computer for driver software".

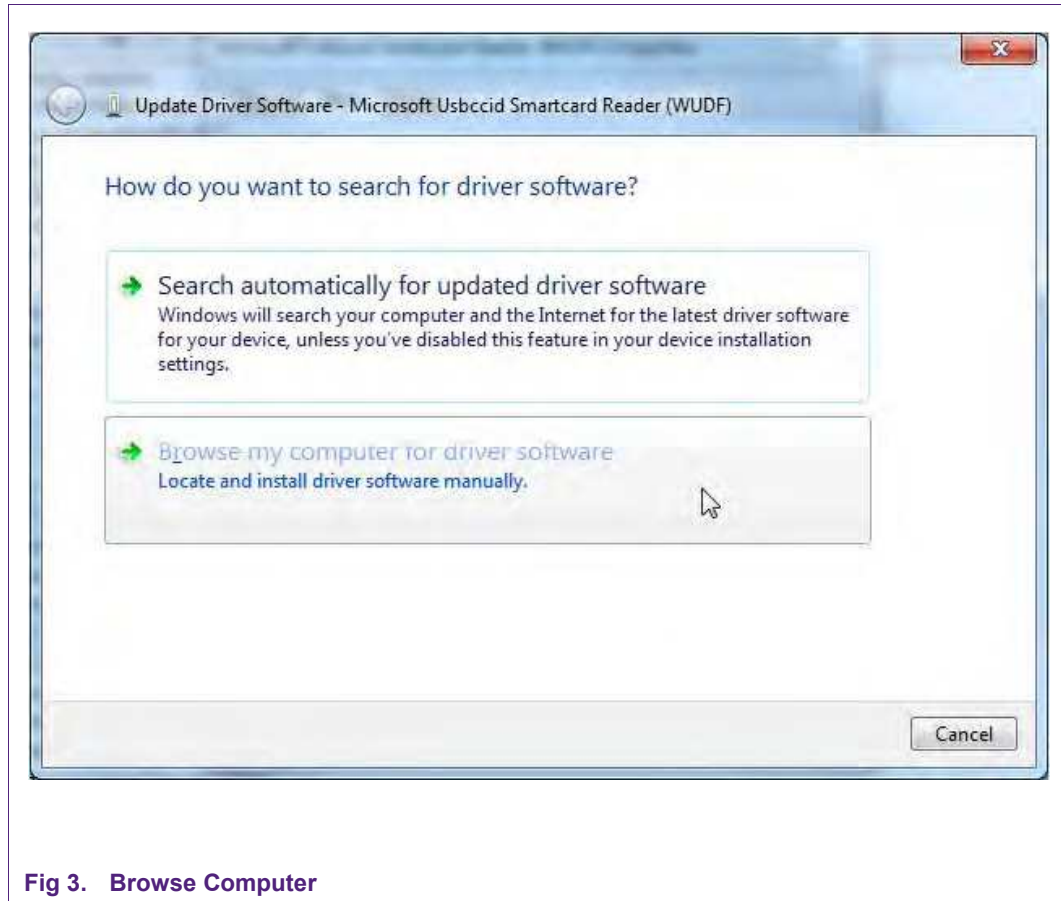


Fig 3. Browse Computer

- 11) Choose "Browse", navigate to the root directory of the CD or the previous extracted content and click "Next".



Fig 4. Browse for driver software on your computer

12) Wait until Windows has finished the installation.

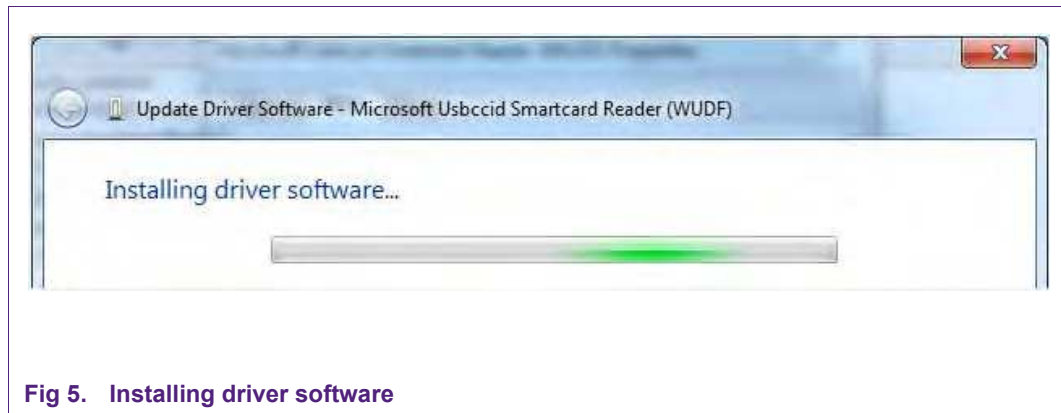


Fig 5. Installing driver software



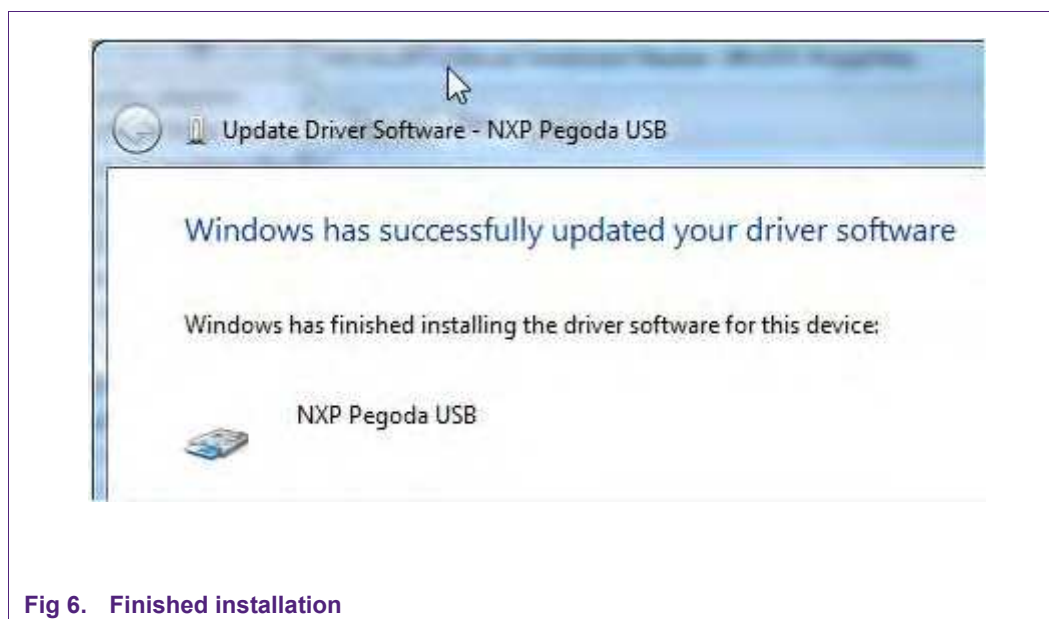


Fig 6. Finished installation

13) The installation is done.

## 2.4 Deactivate Smart Card Interface

For some customers it may be useful to deactivate the Smart Card Interface. This is especially important for users of Windows 7. If you see that Windows repeatedly tries to install a new Smart Card Interface you need to do the following steps.

1. Go to the Control Panel of your computer (Start – Control Panel)
2. Click “System” – “Device Manager” and then “Other devices”
3. Click “Smart Card” with your right mouse button and then disable.

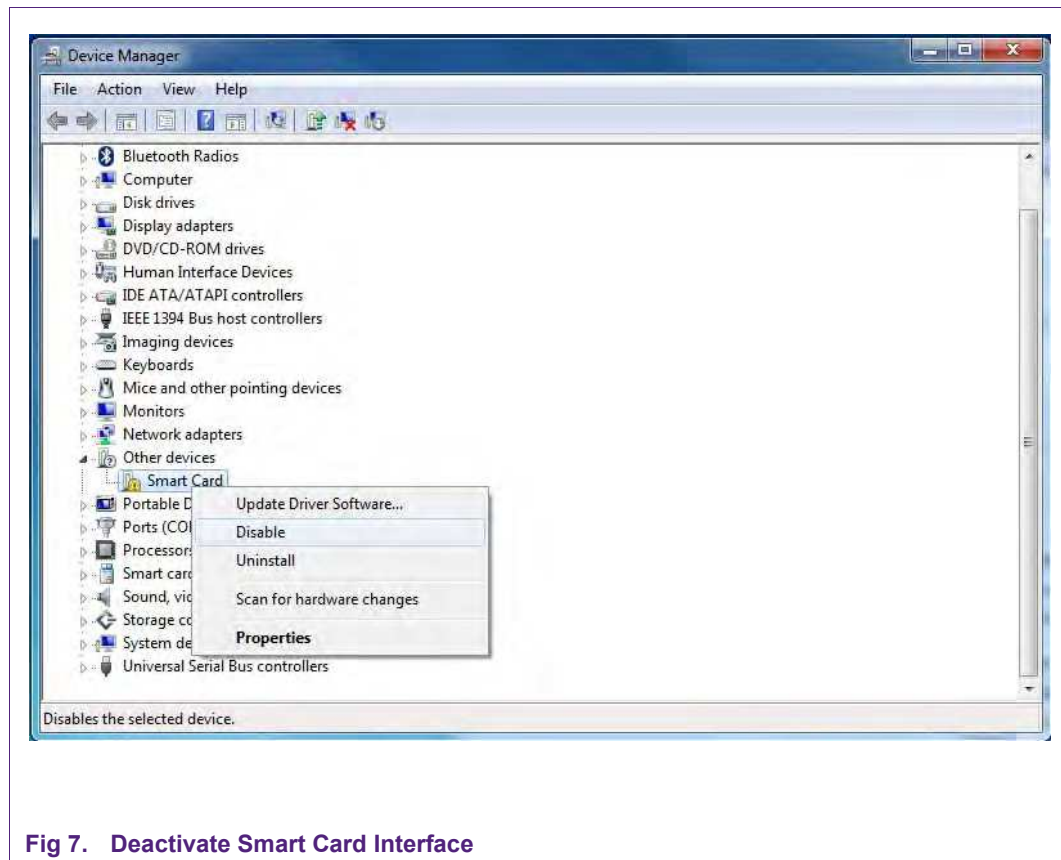


Fig 7. Deactivate Smart Card Interface

## 2.5 Pegoda2Go

Pegoda2Go is a small program to check the basic functions of the RD710. It can be started directly for the CD (\Software and Tools\Pegoda2GO.exe)

If the driver is installed correctly and the Pegoda is connected the device should be present in the 'Reader' menu. May hitting the 'Refresh' item is required.

Once the reader is selected the Action menu allows to switch the Antenna LEDs and to get information about the Pegoda configuration and the used firmware version as shown in figure Fig 8. If a card is present in the reader field the basic information of this card can be shown as well.

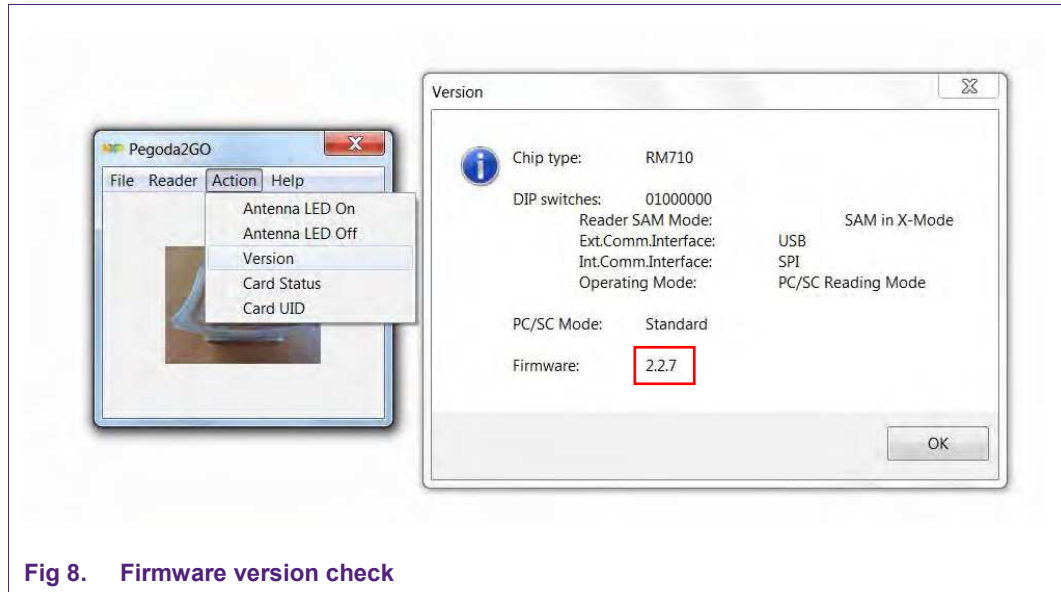


Fig 8. Firmware version check

## 2.6 Installing MIFAREdiscover

There are two different versions of MIFAREdiscover; for once the full version can be retrieved from the doc store and the public version, which can be downloaded from the NXP Homepage.

The public MIFAREdiscover supports the functions for MIFARE Classic (see[8]) MIFARE Ultralight (see[11]), General ISO/IEC 14443-A (see[7]) protocol handling.

The full MIFAREdiscover supports the functions for MIFARE SAM AV2 (see [23]-[34]) support (X and conventional), MIFARE Plus (see [4]) MIFARE DESFire EV1 (see [3]), MIFARE Classic, MIFARE Ultralight, MIFARE Ultralight C (see [5]) and General ISO/IEC14443-A protocol handling.

### 2.6.1 System Requirements

- Microsoft Windows XP SP2 or higher
- Minimum screen resolution 1024x768 pixels
- Microsoft .NET Framework 3.5 Service Pack 1 or higher [will be installed along with this installer]
- Pegoda
- MIFARE SAM AV2 for X-mode

### 2.6.2 Installation process

Install Microsoft .NET Framework 3.5 SP1 (or higher if available)

- The Installer "SetupMIFAREdiscover" tries to install the Microsoft .NET Framework 3.5 Service Pack 1 by using a Net-Installer. If you have limited or no network

connection to download and install the Microsoft .NET Framework the setup process is terminated and you have to install the Microsoft .NET Framework manually.

- .NET Framework can be found online (see [48])
  
- Install the "SetupMIFAREdiscover" package:  
Install the package and follow the instructions. The whole installation process requires administration rights. After you have successfully installed the program "MIFAREdiscover" and all of its required components you can start "MIFAREdiscover" via the link  
"Start -> All Programs -> NXP Semiconductors -> MIFAREdiscover -> MIFAREdiscover".
  
- Read "ReleaseNotes.txt" file that you received with the MIFAREdiscover package.

### 3. Demo mode and DIP switch configuration of the Pegoda

#### 3.1 DIP switch configurations for various Reader modes

DIP SWITCH NUMBER								READER	MODE
8	7	6	5	4	3	2	1		
OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	RD862	IN PCSC MODE
OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	RD710	NO SAM
OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	RD710	IN S-MODE
OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF	RD710	IN X-MODE
ON	ON	OFF	OFF	OFF	OFF	OFF	OFF		FLASH MODE

01/2006/033

**Fig 9. Overview of important reader modi**

You can find a photo with description on NXP web (see [40]) (table and figure 1)

#### 3.2 Demo mode

To get into demo mode, configure the DIP switch as follows

8	7	6	5	4	3	2	1
OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF

and connect the USB cable. Only power is provided by the USB cable, the reader itself works autonomously without interaction of the PC.

The demo mode is used to showcase some basic functionality of the reader. In this mode, ISO/IEC 14443-3A and ISO/IEC 14443-3B activation loop is performed and an acoustic signal is generated based on the detected card and **SAK-byte**, respectively.

The following table depicts the default sound coding for different MIFARE cards:

**Table 1. Card type according to SAK and number of beep**

Card Type	beep	blink
MIFARE 1K (0x08)	1	2
MIFARE Classic 4K (0x18)	2	2
MIFARE Ultralight (0x00)	3	2
MIFARE DESFire	4	2
MIFARE Plus	5	2
ISO/IEC 14443 Type B	1	1

If you still using the older firmware (v1.x) this demo mode behaves slightly different. There is no ISO/IEC 14443-3B activation loop and the reader reacts as described in the following table.

**Table 2. Card type according to SAK and number of beep for old firmware version**

<b>Card Type</b>	<b>Beep and blink</b>
MIFARE 1K (0x08)	1
MIFARE Classic 4K (0x18)	2
MIFARE Ultralight (0x00)	3
MIFARE DESFire	4
MIFARE Plus	5

This can be used to determine which firmware is currently running on the reader.

## 4. Public Version

All in this section explained steps are applicable to the full version as well.

### 4.1 Starting MIFAREdiscover

Connect the RD710 Reader with the PC by using the USB cable. Choose the desired DIP switch configuration on the mainboard of the reader (see chapter 3.1) as this tool does not support SAM. The DIP switches should all be set to “OFF”.

Start MIFAREdiscover from the Start menu.

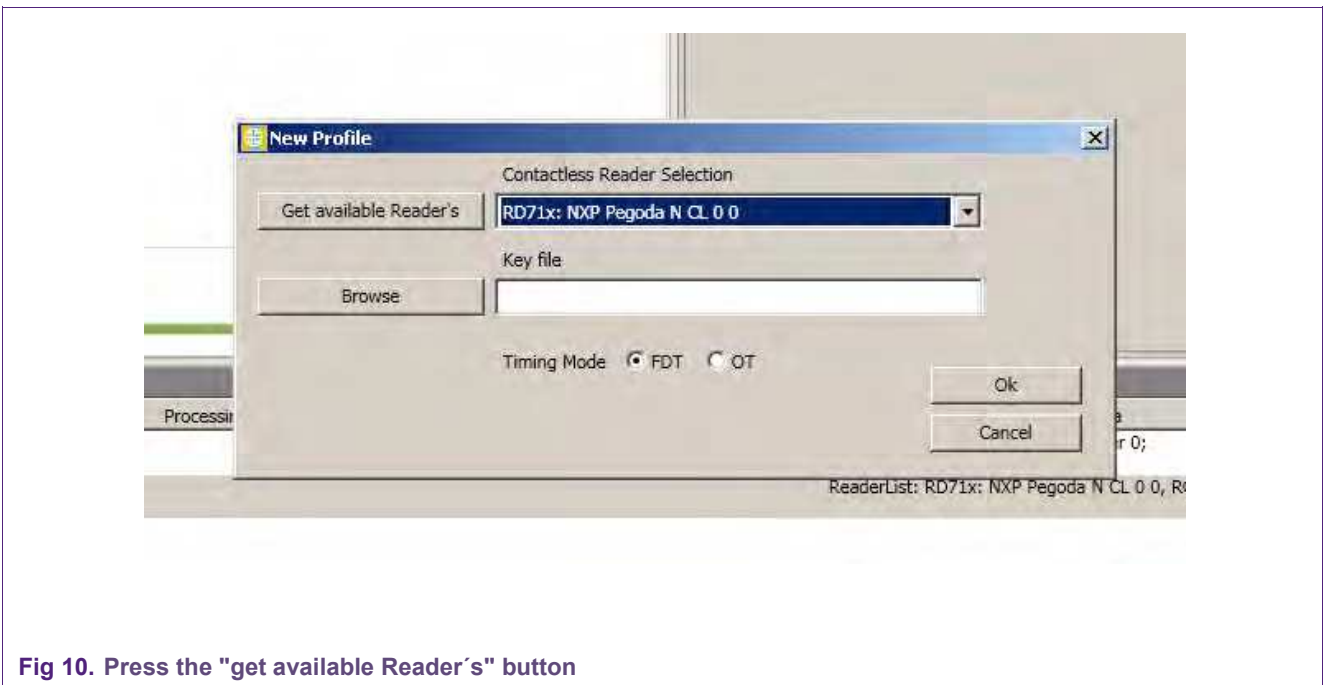


Fig 10. Press the "get available Reader's" button

Press “Get available Reader’s” for the drop down field “contact- and contactless reader selection”. The available readers will be listed depending on the DIP switch configuration and the chosen reader.

Press “Ok” to open the mainframe of the MIFAREdiscover program for the specific reader configuration.

The following main window will appear. The History frame shows you that the reader has been opened successfully. The configured reader mode can be depicted from the history list as well.

### 4.2 Mainframe general overview

The public MIFAREdiscover supports the functions for MIFARE Classic (see [9]), MIFARE Ultralight (see [11]), General ISO/IEC 14443-A (see [7]) protocol handling.

Therefore, the user interface is divided into functional blocks which are shown in different tabs in Fig 11 (1).

They open the so called ‘Command selection’ window (2) which allows to select a command window in (3).

At the bottom (4) Fig 11 shows the history field where all the operations are displayed. For a more detailed view on the sent data and received data a switch to the log window is possible. Both fields can be cleared, or can be stored in a text file.

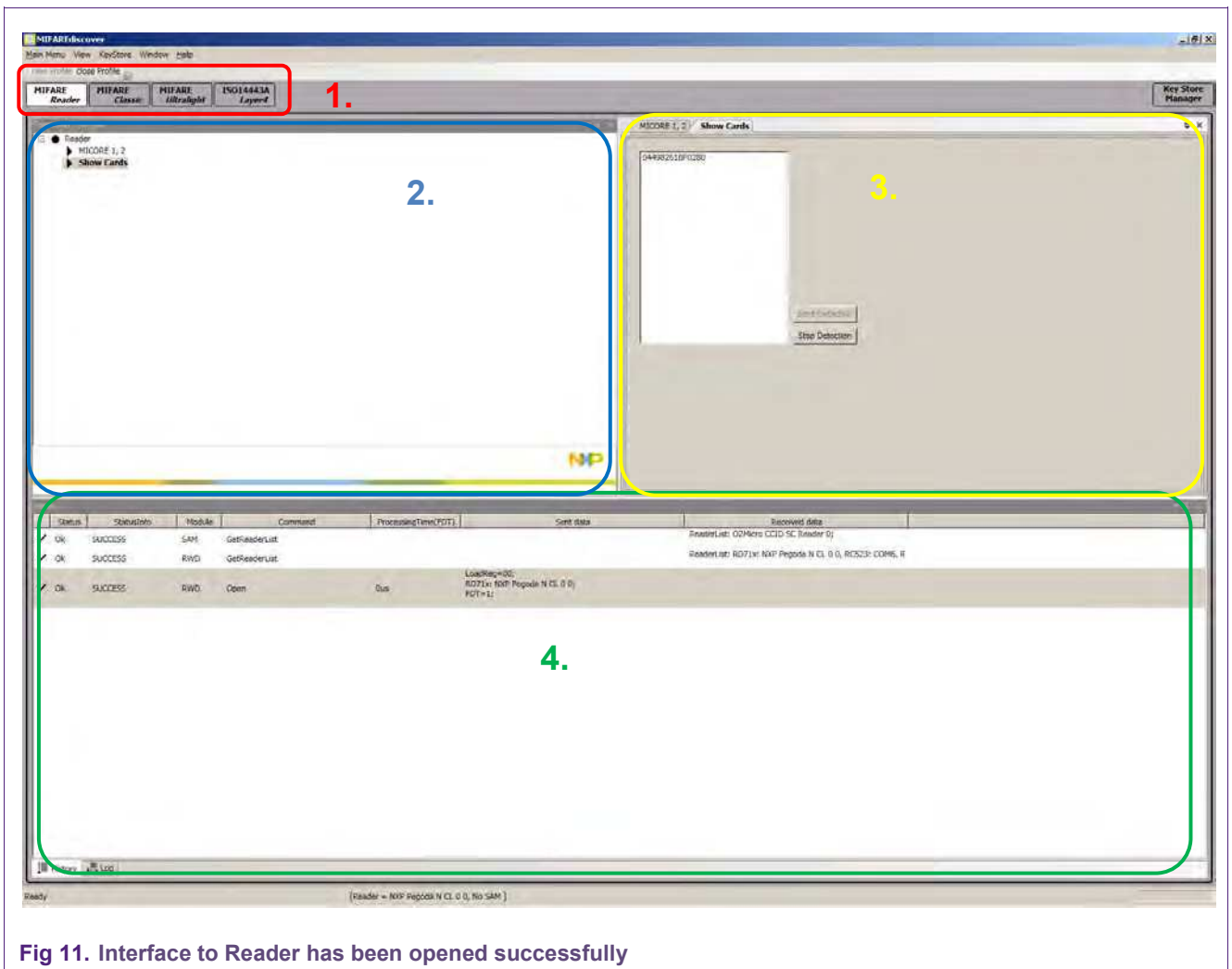


Fig 11. Interface to Reader has been opened successfully

Note: The sequence of commands as described in ISO/IEC 14443 or in the relevant datasheet must be kept to be able to activate and operate a card. The MIFAREdiscover does not cross check the logical command flow.



### 4.2.1 MIFARE Reader

With this tab you can control the basic functions on the reader.

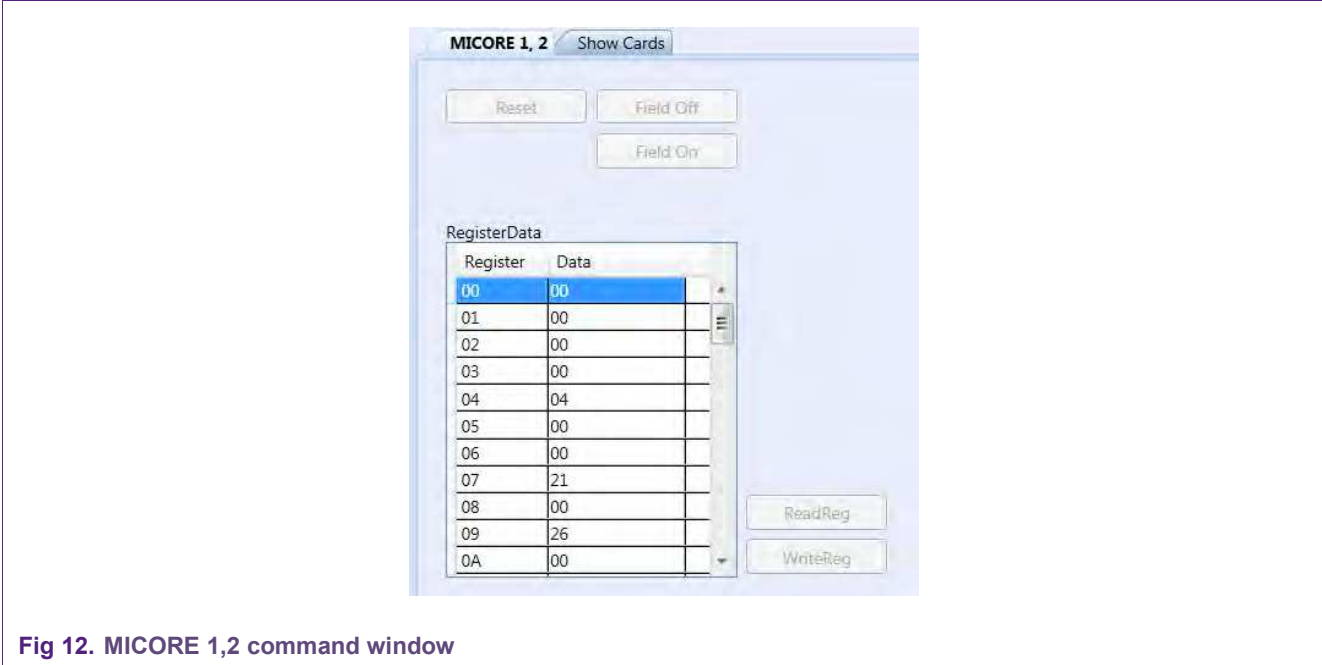


Fig 12. MICORE 1,2 command window

The "MICORE 1, 2" command window allows you to reset the reader and to turn the electromagnetic (card reading) field off or on. The commands 'ReadReg' and 'WriteReg' allow reading or writing the register to control the reader. For further information on the register settings and functions please refer to the individual Reader ICs data sheet.



Fig 13. Show Cards command window

The 'Show Cards' command window in Fig 13 allows you to detect all the cards which are present in the reader field. With 'Start Detection' the reader starts to poll for cards (ISO 14443 Type A and B) and you get the UID of the cards presented to the Pegoda as well as the card type. With 'Stop Detection' the polling is stopped again.

4.2.2 MIFARE Classic

The command window “ISO14443A Layer 3” is shown in Fig 14.

1. This part of the panel allows you to activate a number of cards and perform the anti-collision protocol according to [7] . The most convenient method is to push the ‘Activate Idle’ button. After that, in the table a UID appears in section 2 and its State is ‘Active’.
2. This section allows you to manage multiple cards in the reader field. Select a specific card you want to communicate with. Therefore this card has to be in ‘Active’ State. To switch to another card in the reader field choose the current ‘Active’ card and with ‘Halt’ you can change the State from ‘Active’ to ‘Halt’ state (and work with another card in the meantime). Pick a ‘Halt’ UID and the button ‘Act.Wakeup’ changes the State back to ‘Active’ and you can work with the card again. ‘Clear List’ deletes all data in the table

With the control elements in the blue section you can send individual commands and data to the card in an ISO 14443 Layer3 message frame. Thereby the input format is hex coded. The checkboxes there indicate if you want to append a CRC code to the command and if you expect that the card to append a CRC to the response. The answer of the card is then displayed in the log windows. For a list of available command please refer to cards datasheet.

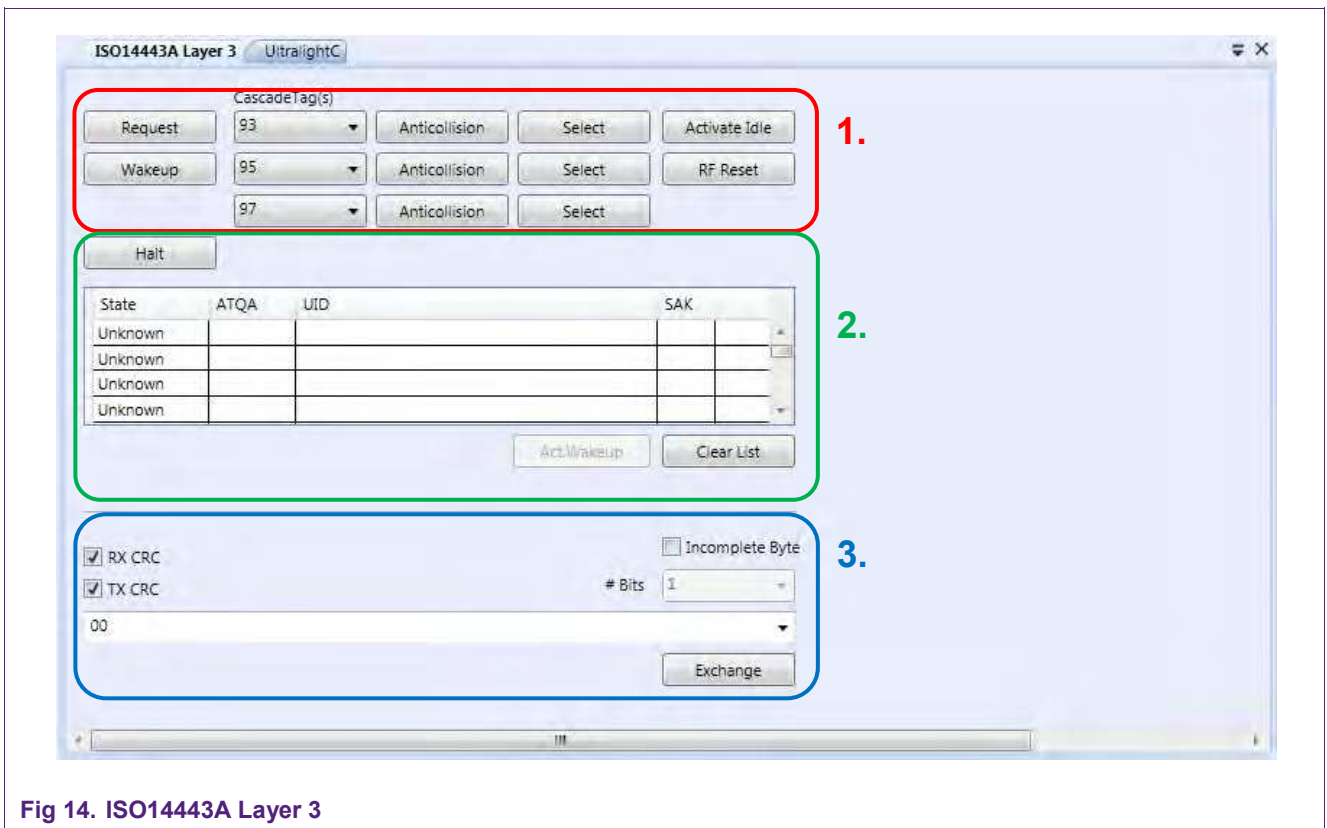


Fig 14. ISO14443A Layer 3

Fig 15 shows the ‘Data Processing’ window. With this window you can process the data stored on the MIFARE Classic card:

1. 'Personalization UID Usage' allows you to configure the type of UID the card should use. For the available types please refer to [8][8].
2. To gain access to the different storage sectors of the card you first need to authenticate with a Key. Therefore you can choose a 'BlockNo' and the 'Ref Key' (prepared in the KeyStore 5.3.2.3) and use the button 'MFC Auth Key A' or 'MFC Auth Key B'.
3. With 'Read' you can read a block from the card and with 'Write' you can write the block on the card then is selected in the data grid. Use 'Increment' to increase and 'Decrement' to decrease the contents of a block. The results are stored in an internal data-register. The 'Restore' button move the contents of a block into an internal data-register. Use 'Transfer' to write contents of the temporary internal data-register to a value block.

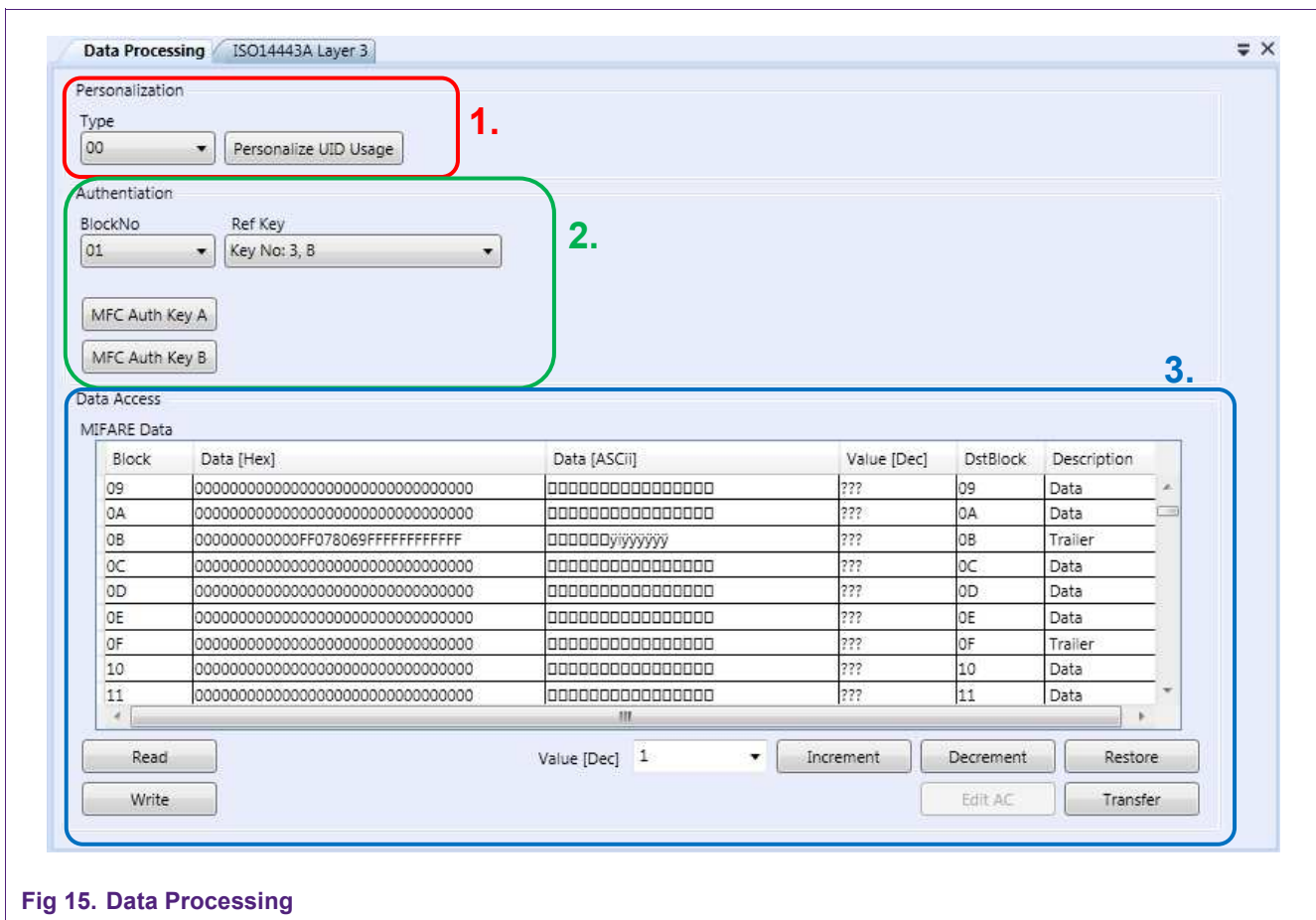


Fig 15. Data Processing

### 4.2.3 MIFARE Ultralight

The Ultralight tab provides the 'ISO14443A Layer 3' command window as well. For the provide functionality please see section 4.2.2.

The 'Ultralight' command window allows:

1. To read and write data on a chosen page of the card.
2. To write Lock Bytes (refer to [21]).

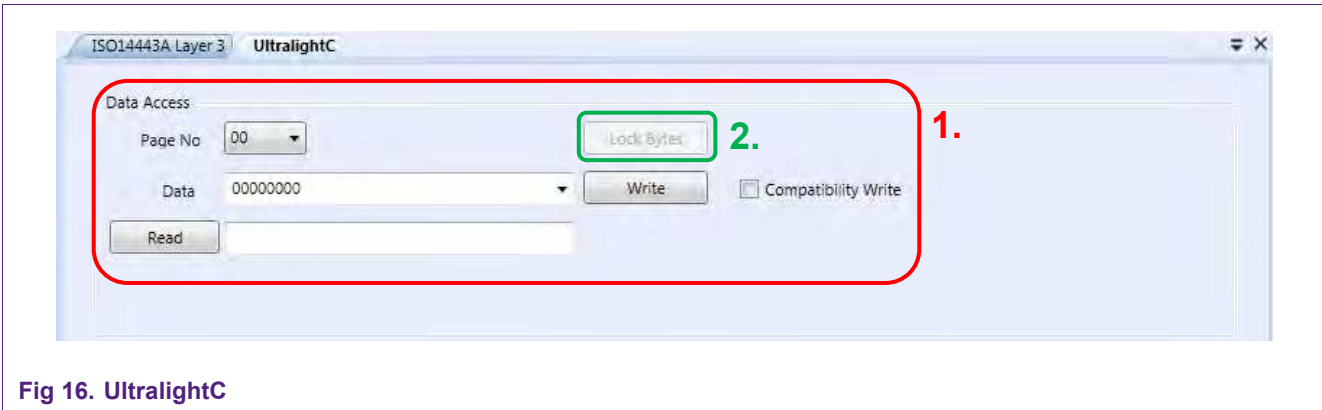


Fig 16. UltralightC

#### 4.2.4 MIFARE ISO14443A Layer 4

This tab provides all the functionality to work with ISO14443A Layer 4 [7] and the command window is shown in Fig 17.

1. This part can be use to activate a card to Layer 4 and control the date exchange rate.
2. The textbox shows the State of the cards. Control which card is the active one.
3. Use the blue marked part to send commands to the card in a ISO14443A Layer4 message frame format.

For more information on the provided commands of this window please refer to [7].

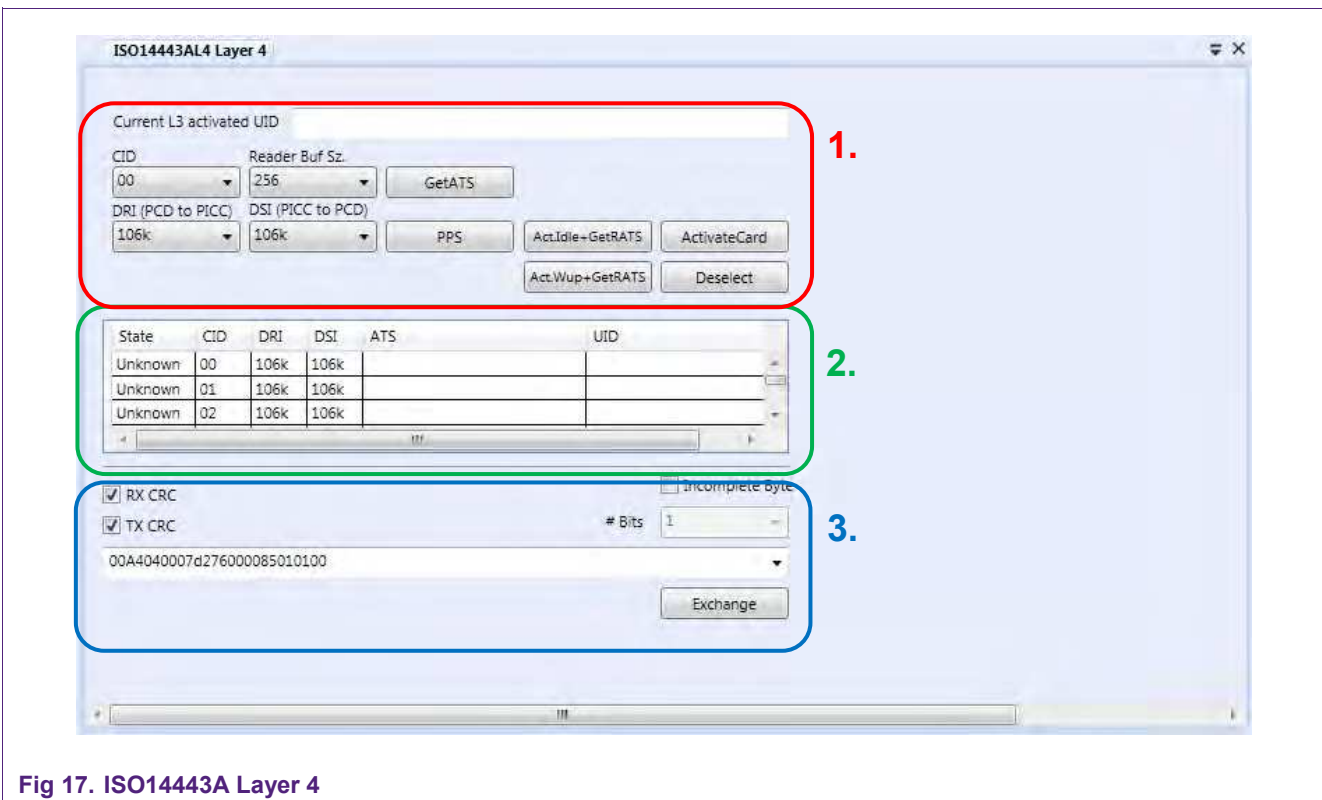


Fig 17. ISO14443A Layer 4

### 4.2.5 Key Store Manager

The Key Store Manager window as shown in Fig 18 allows you to define a number of Keys to be used for the authentication of e.g. memory sectors.

Each key block can have a nickname and a certain type. It is divided in 3 keys, A B and C with individual Versions.

From more information on keys and how to be used with cards please refer to the individual card IC datasheets.

Key No	Name	Key Type	Entry PartA	Version A	Entry PartB	Version B	E
0	name	MIFARE	FFFFFFFFFFFF	00	000000000000	01	01
1	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
2	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
3	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
4	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
5	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
6	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
7	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
8	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
9	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
10	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
11	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
12	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
13	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
14	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
15	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01
16	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	01

Fig 18. Key Store Manager

## 5. Example of some use case for the public version

### 5.1 Accessing the MIFARE Classic

Open the 'MIFARE Classic' Tab and select 'ISO 14443A Layer 3'. On the right side you can see a number of buttons for the activation of the card. The most convenient method is to push the 'Activate Idle' button. Then a UID appears in the table and the state changes to 'Active'.

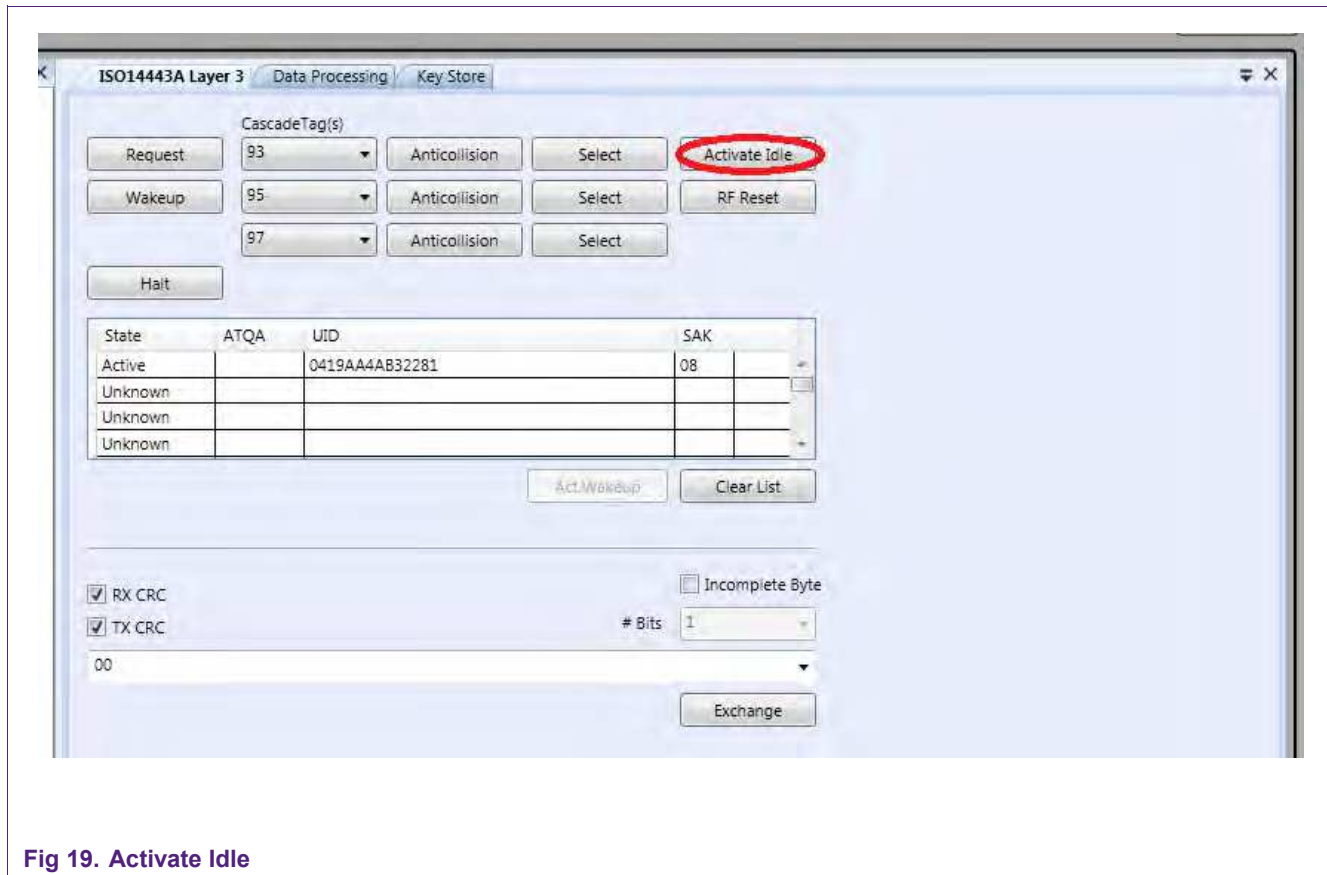


Fig 19. Activate Idle

Now open the Key Store Manager and select the following settings for the first Key:  
 Key Type: MIFARE, Entry PartA: FFFFFFFFFFFFFFFF, Version: 0 as shown in Fig 20.

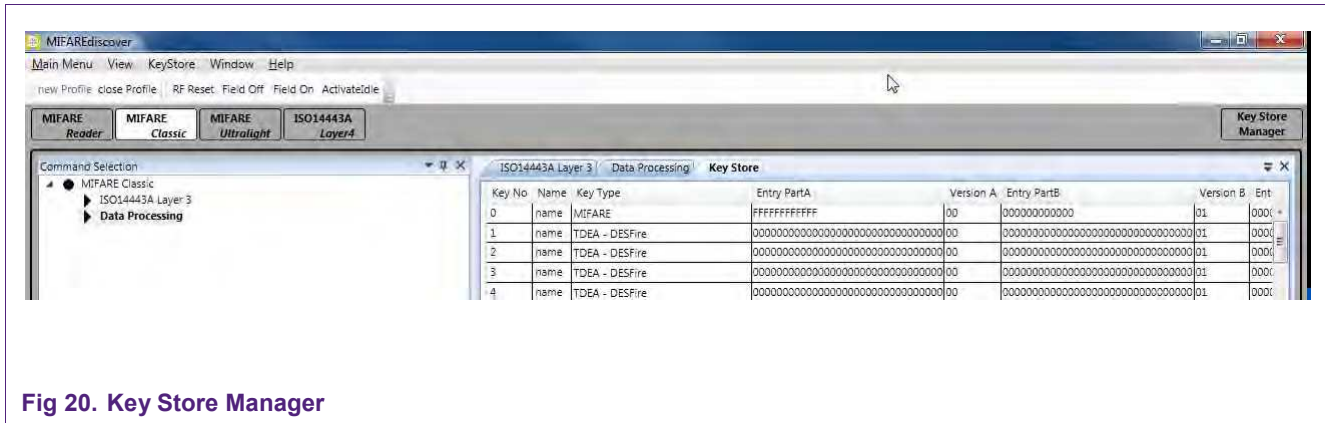


Fig 20. Key Store Manager

Leave the Key Store Manager and select “Data Processing”.

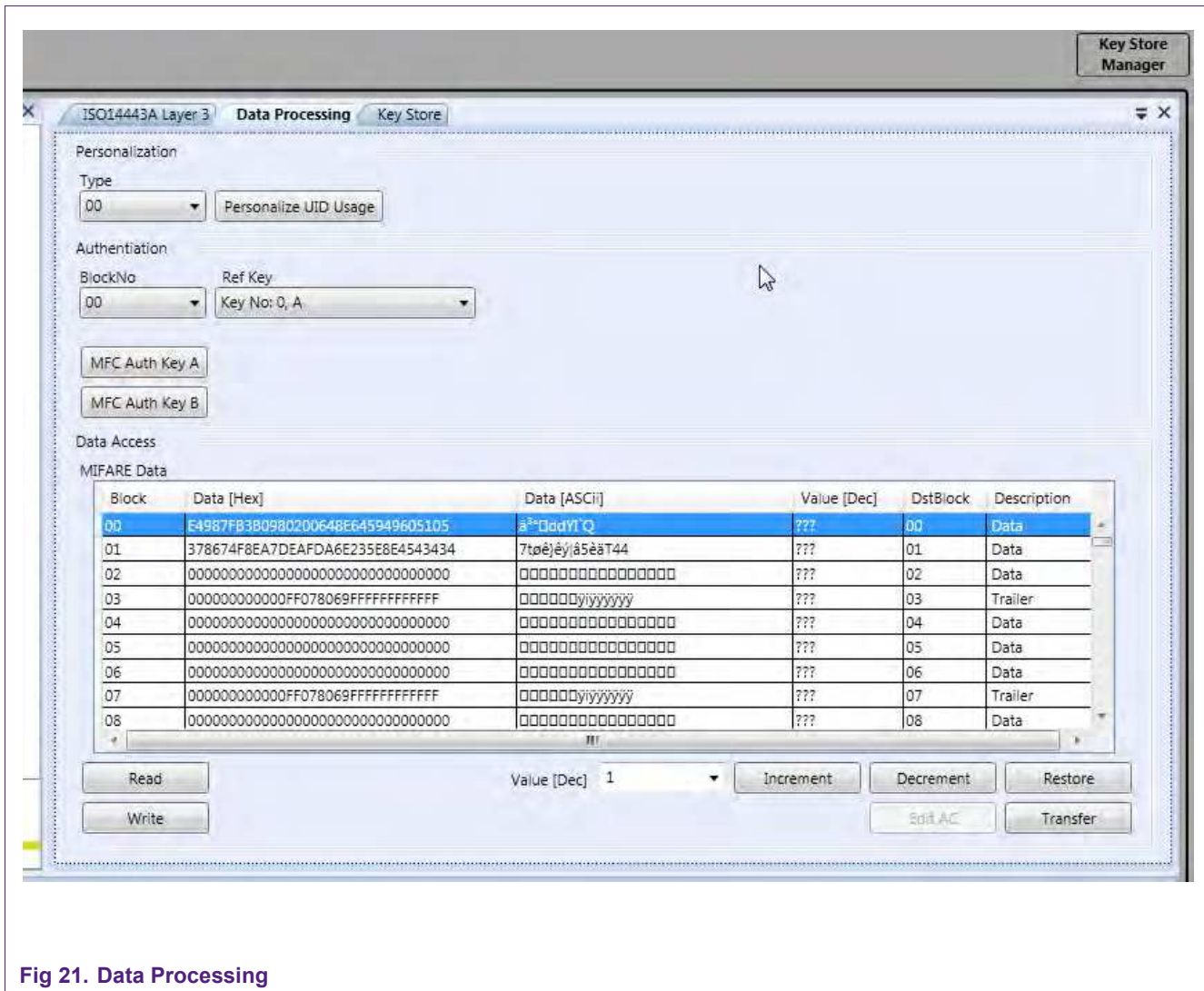


Fig 21. Data Processing

Select BlockNo 00, Ref Key 0, A and click "MFC Auth Key A"

Now you should be able to read Sector 0 (Blocks 0-3).

Select BlockNo 04, Ref Key 0, A and click "MFC Auth Key A"

Now you should be able to read and write in Sector 1 (Blocks 4-7).

The same is for all the other blocks and sectors.

### 5.2 Accessing the MIFARE Ultralight

Open the 'MIFARE Ultralight' Tab and select 'ISO 14443A Layer 3'. On the right side you can see a number of buttons for the activation of the card. The most convenient method is to push the 'Activate Idle' button. Then a UID appears in the table and the state changes to 'Active'.

Then select the "Ultralight" command window.

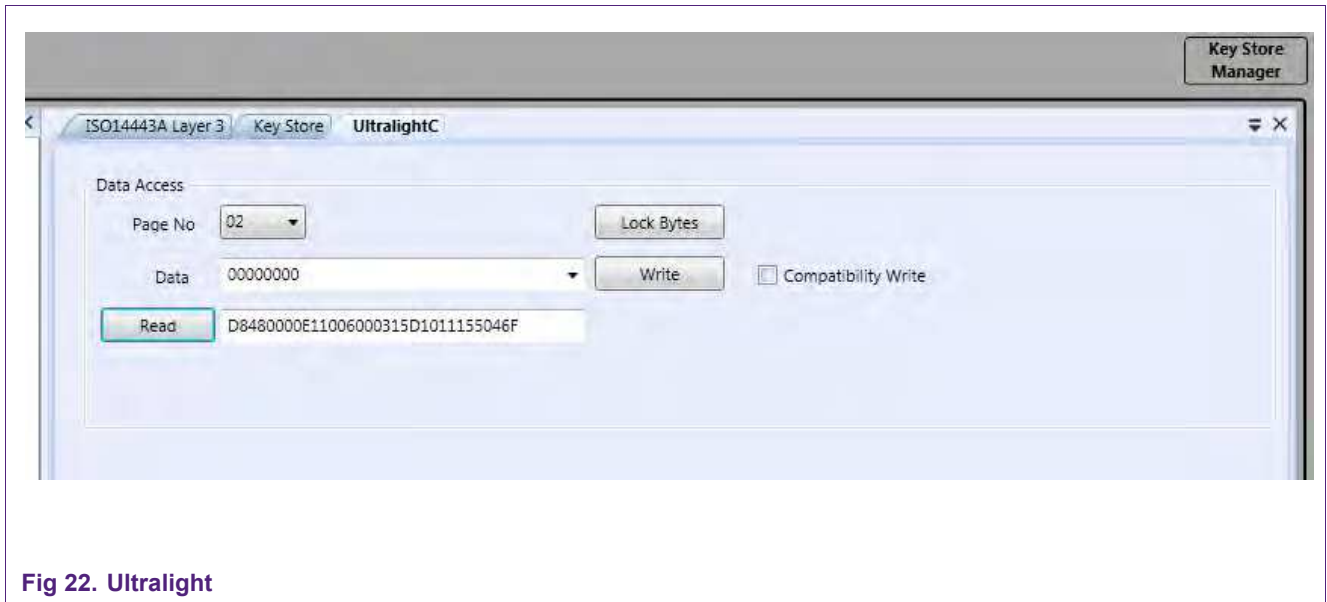


Fig 22. Ultralight

Select a 'Page No' and click 'Read' to read the data in the second text box. You also can write 4 Bytes into the first text box and click 'Write' to transfer it to the card.

If you check the 'Compatibility Write' box you can write 16Byte at once (compatible to MIFARE Classic). The data is then distributed to 4 pages starting with the one selected at Page No.

NOTE: Start writing at Block 3. The first three blocks (0 – 2) are reserved for the UID, some internal data and the lock bits of the memory.

Keep in mind that you can only write when the lock bits (Block 2, Byte 2 and 3) are all set to 0b (read and write permission).



### 5.3 Writing NFC Tag

MIFARE discover can be used to format MIFARE Card products to act a NFC Tags (refer to [17]) and store NDEF messages on them. The following examples show how to store an url in this format on the card to make it accessible from NFC devices. Therefore the NDEF Message format is explained briefly.

#### 5.3.1 The NDEF message

A NDEF message is composed of one or more NDEF records as shown in figure Fig 23. Each Record has a Header and a Payload. The header is made of the Identifier, Length and Type.

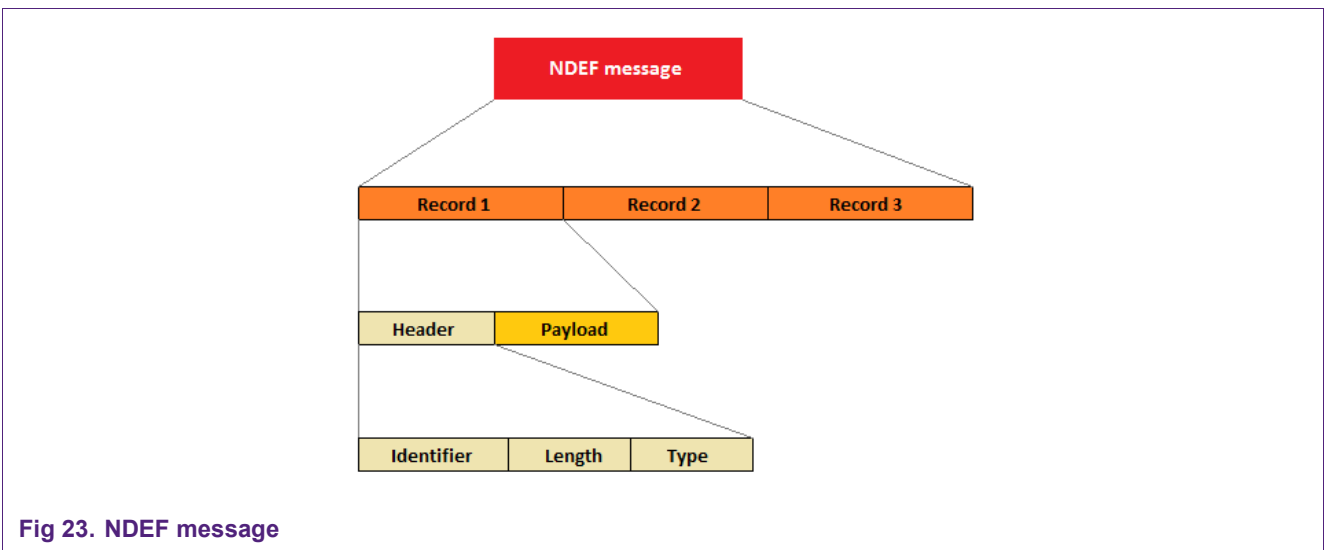


Fig 23. NDEF message

The NDEF message use for the following examples should contain the url <http://www.nxp.com>. Therefore the coded message has to look as followed:

03 | 0C | D1 | 01 08 55 01 6E 78 70 2E 63 6F 6D | FE

The message starts with the Message TLV (Type Length Value) '03 0C D1'.

- 03 – NDEF Record (this byte defines the type of record)
- 0C – tells, how many bytes in the payload are
- D1 – Type of the record (first record? last record? short record? etc.)

- 01 – Type length (specifies the length of the Type field)
- 08 – Payload length, bytes that are used for the payload (01 6E 78 70 2E 63 6F 6D)
- 55 – Type field ('55' = 'U' and means URI)
- 01 – URI Identifier ('http://www.')
- 6E 78 70 2E 63 6F 6D - Payload, the rest of the string in hex-code (nxp.com)

FE – Terminator TLV ('Message is finished')

For details about the TLV refer to [22]. And if you want to read more information about creating a NDEF Message, please refer to [19].

5.3.2 MIFARE Classic as NFC Tag

This part now shows how you can use the MIFARE Classic as NFC Tag [16] and put a NDEF message on a blank Card. We use the previously explained message url NDEF message and store it on the Card.

5.3.2.1 Default factory settings MIFARE Classic

First there is some informative data about a MIFARE Classic Card [8][8].

- 16 Sectors (0 – 15)
- Standard Key A = FFFFFFFFFF and standard Key B = FFFFFFFFFF
- Access bits are set to 'FF0780' and the GPB is '69'
- You can read and write only with Key A
- You cannot write in Block 0 of Sector 0

Every Sector contains 4 Blocks (0 – 3). Block 3 is always the Sector Trailer which contains Key A, the Access Bits, GPB and Key B of the Sector. Block 0, 1 and 2 are for storing data.

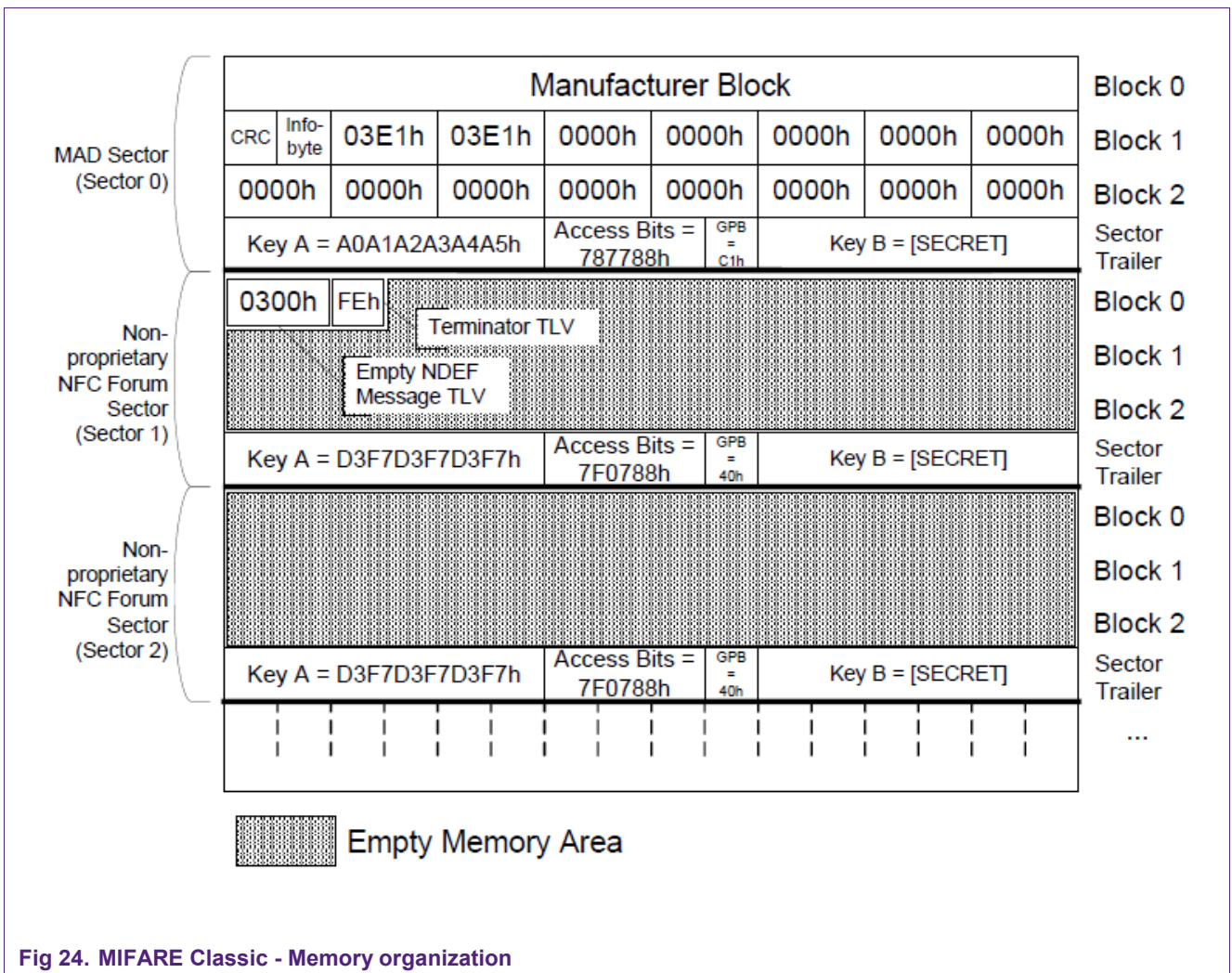


Fig 24. MIFARE Classic - Memory organization

The only exception is Sector 0. Block 0 is read-only and contains the UID. The first two bytes of Block 1 are for the CRC byte (cyclic redundancy check) and the Info byte. There are 30 bytes remaining in Block 1 and 2. These are splitted in groups of two. Every byte-pair represents one Sector, starting at 1 and ending with 15.

Further Information can be found there: [16]

5.3.2.2 Activate the Card

Use the MIFARE Classic Tab and push the 'Activate Idle' button to communicate with the current card.

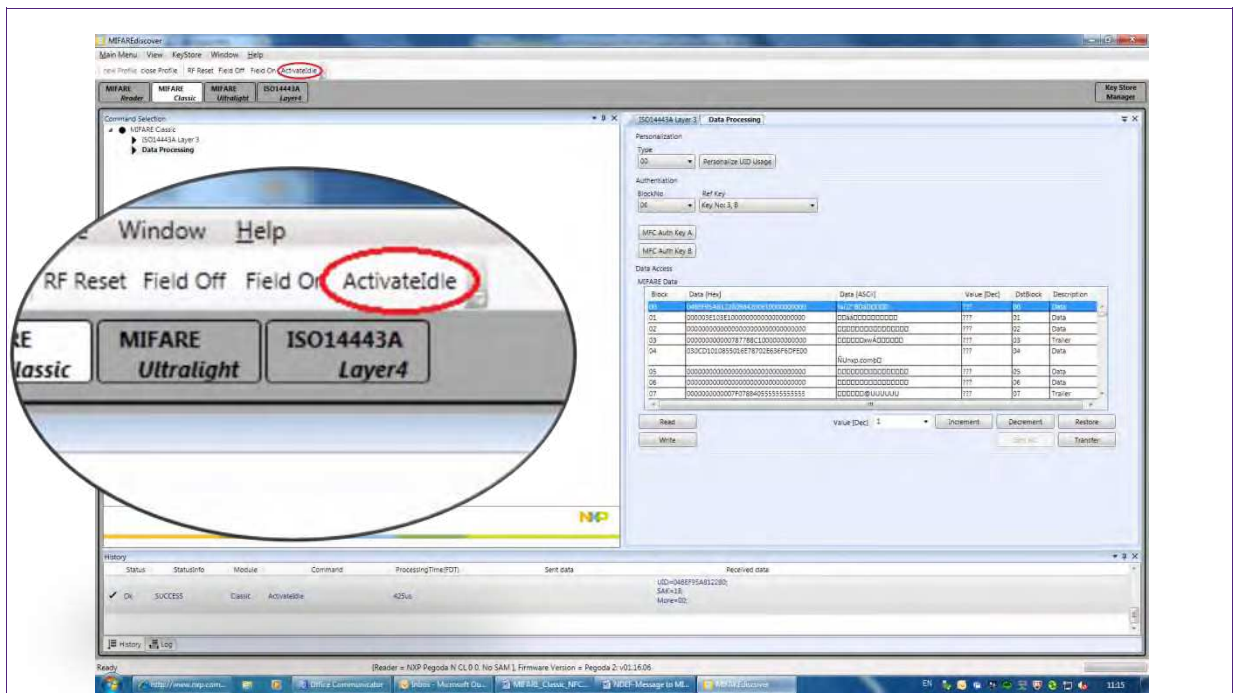


Fig 25. Push 'ActivateIdle'

5.3.2.3 Key Store Manager

For accessing the different blocks of the card you have prepare a certain set of keys. Open the key store and put in the keys as shown in Fig 26.

- The red Key is standard Key A ('Key No: 0, A').
- The blue Key is standard Key B ('Key No: 0, B').

All keys (=standard key) are always set to FFFFFFFFFF, as explained in [8].

- The green Key is the public MAD Key A ('Key No: 1, A').
- The yellow Key is the public Sector Key A ('Key No: 2, A').

The public keys are defined in [16].

Key No	Name	Key Type	Entry PartA	Version A	Entry PartB	Version B	Entry
0	name	MIFARE	FFFFFFFFFFFF	00	FFFFFFFFFFFF	01	0000C
1	name	MIFARE	A0A1A2A3A4A5	00	A0A1A2A3A4A5	01	0000C
2	name	MIFARE	D3F7D3F7D3F7	00	D3F7D3F7D3F7	01	0000C
3	name	MIFARE	000000000000	00	000000000000	01	0000C
4	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	0000C
5	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	0000C
6	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	0000C
7	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	0000C
8	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	0000C
9	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	0000C
10	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	0000C
11	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	0000C
12	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	0000C
13	name	TDEA - DESFire	00000000000000000000000000000000	00	00000000000000000000000000000000	01	0000C

Fig 26. Set MAD Keys

5.3.2.4 Formatting the MIFARE Classic to NFC Tag

The make the Information accessible by an NFC device as certain data structure has to be set in place.

The first step is to set the Keys of the MAD Keys, therefore:

1. To Authenticate for Block 00-03 select BlockNo 00 and standard Key A (Key No: 0, A) and push 'MFC Auth Key A'
2. Write 'A0A1A2A3A4A5787788C1FFFFFFFFFFFF' to Block 03 and push 'Write'

Note: The orange and green highlighted parts are Key A and Key B. The lavender highlighted parts are the Access bits. In this case they stand for read-only with Key A and read and write access with Key B. The yellow highlighted part is the GPB (General Purpose Bit). More information on the coding of these bits can be found in [20].

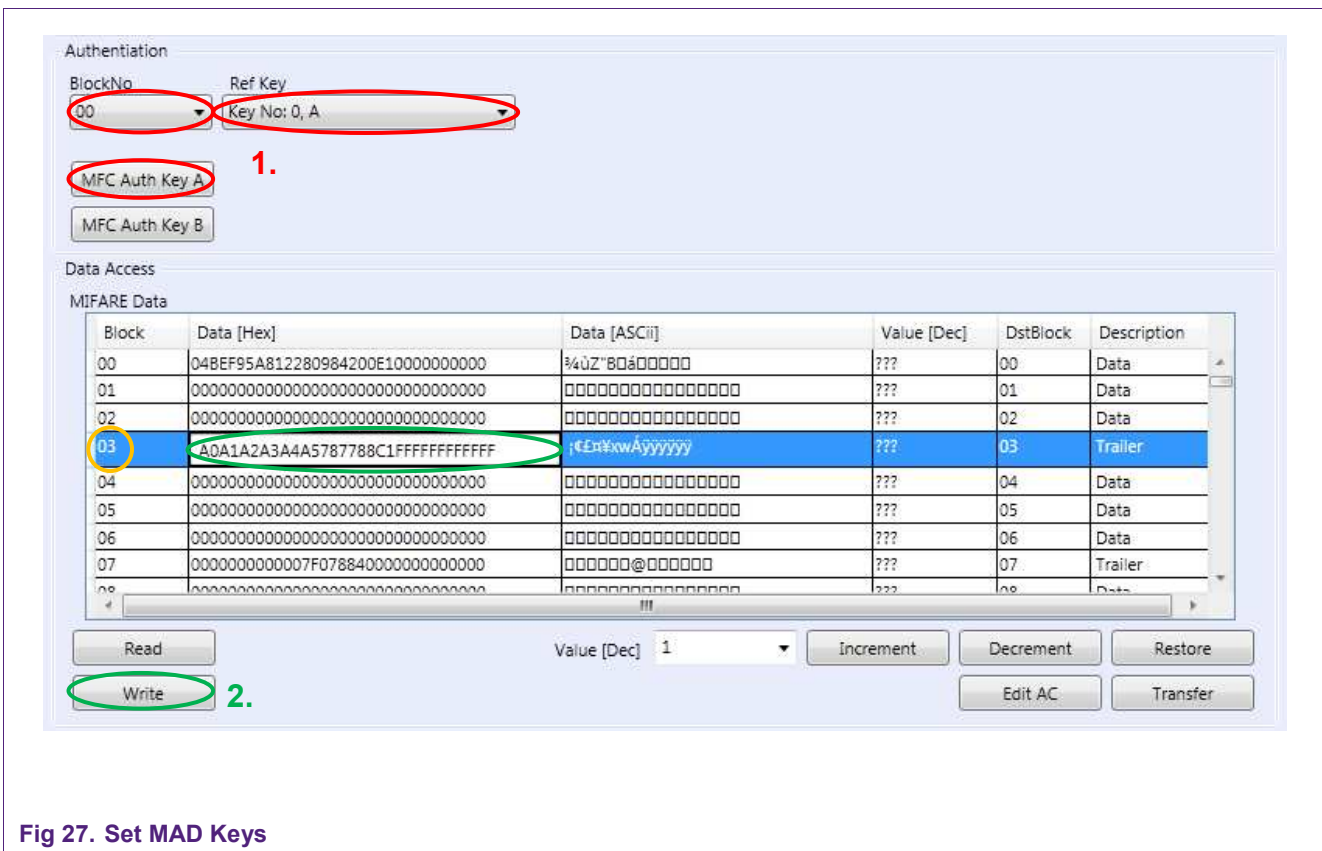


Fig 27. Set MAD Keys

Now the information where to find the NDEF message in the card storage has to be written into the MAD:

1. To authenticate for block 00 to 03 select BlockNo 00 and Key B and push 'MFC Auth Key B'
2. Write 'C00103E1000000000000000000000000' to Block 01 and push 'Write'

03E1 is the NFC AID [22]. C001 contains the CRC and Info – Byte according to [20]. Now you can use Sector 1 of the MIFARE Classic Card to write your NDEF message.

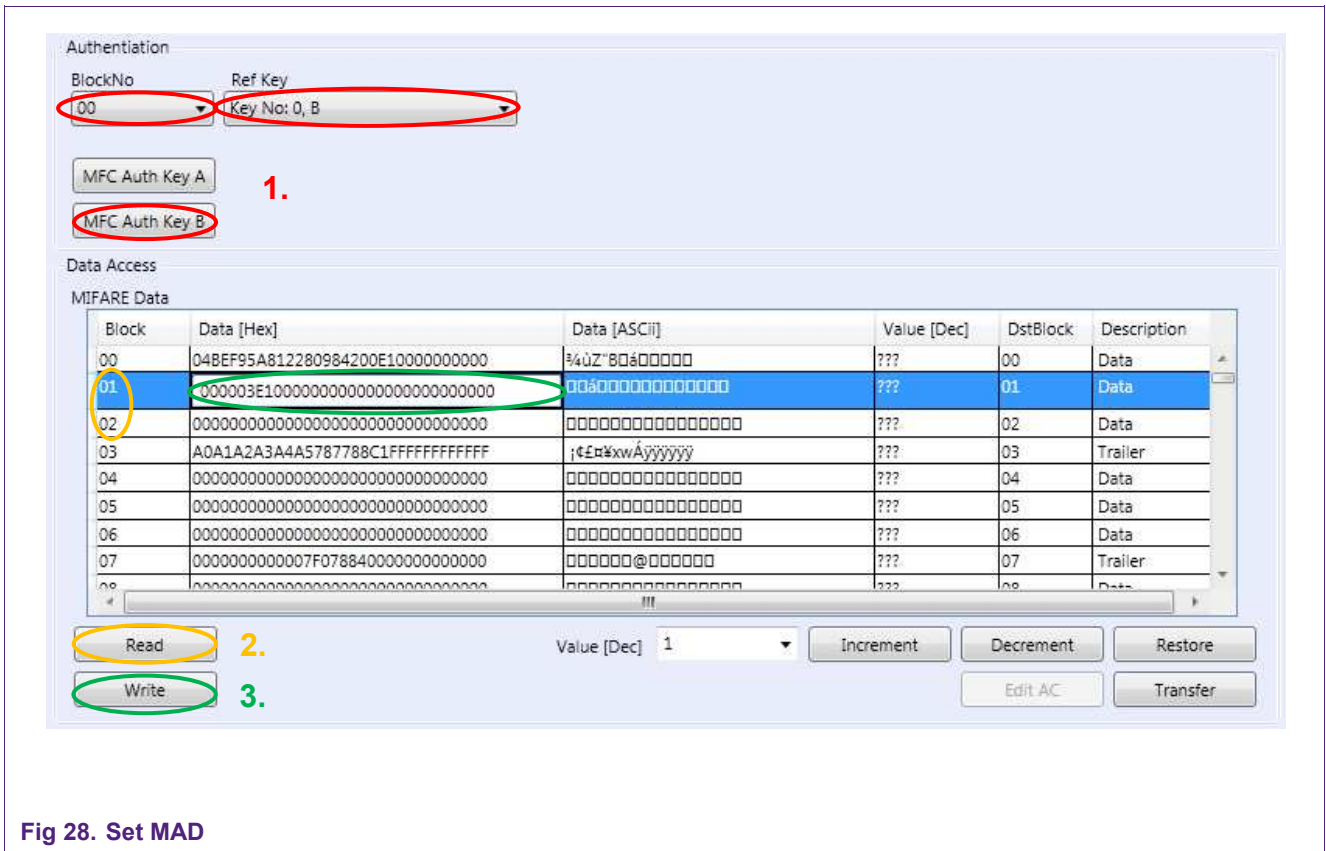


Fig 28. Set MAD

Next the Sector Keys and Access rights for this sector have to be set:

- 3. To authenticate for block 04 to 07 select Block 04 and standard Key A (Key No: 0, A) and push 'MFC Auth Key A'
- 4. Write 'D3F7D3F7D3F77F078840FFFFFFFFFFFF' to Block 07 and push 'Write'

In this case the Access bits 7F0788 stand for read and write access with Key A and B.

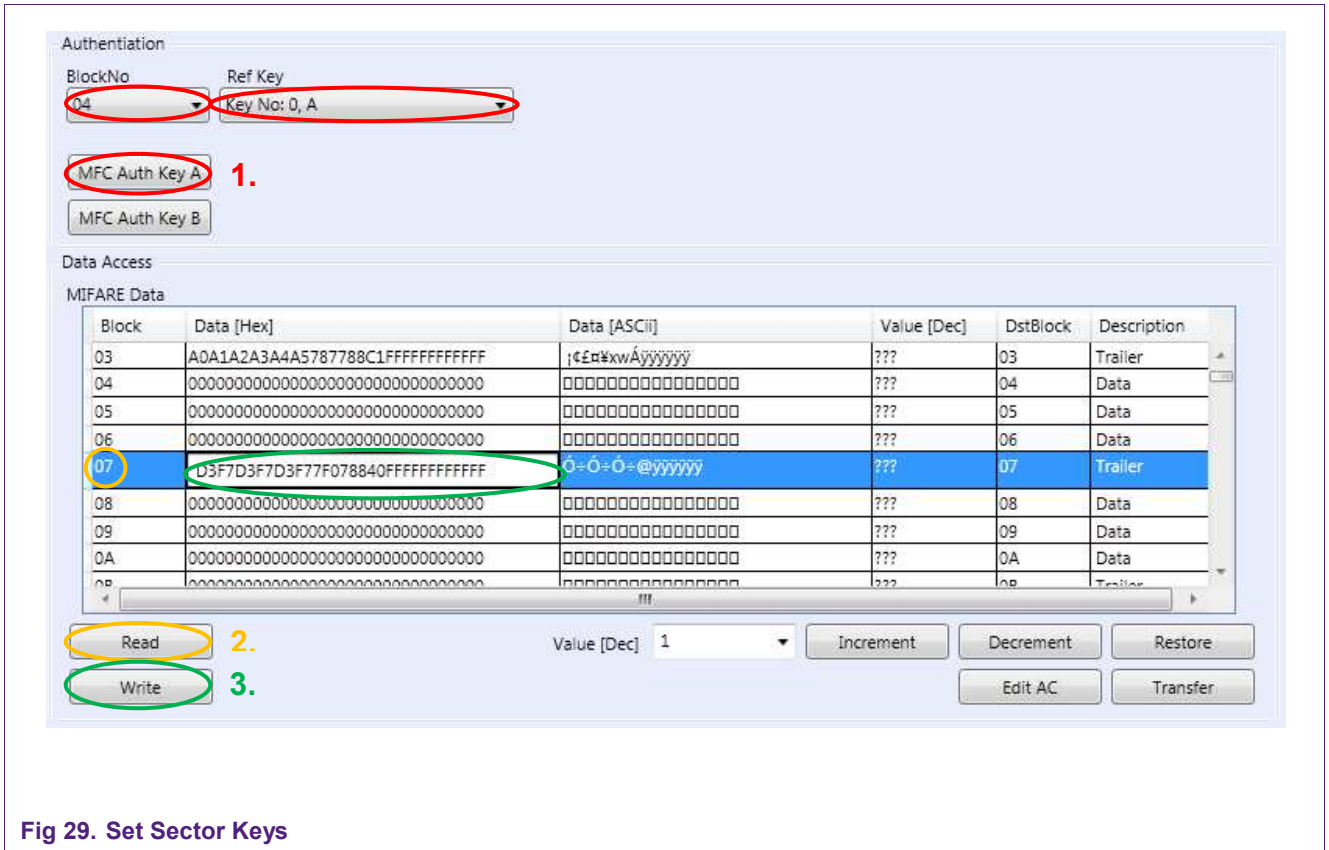
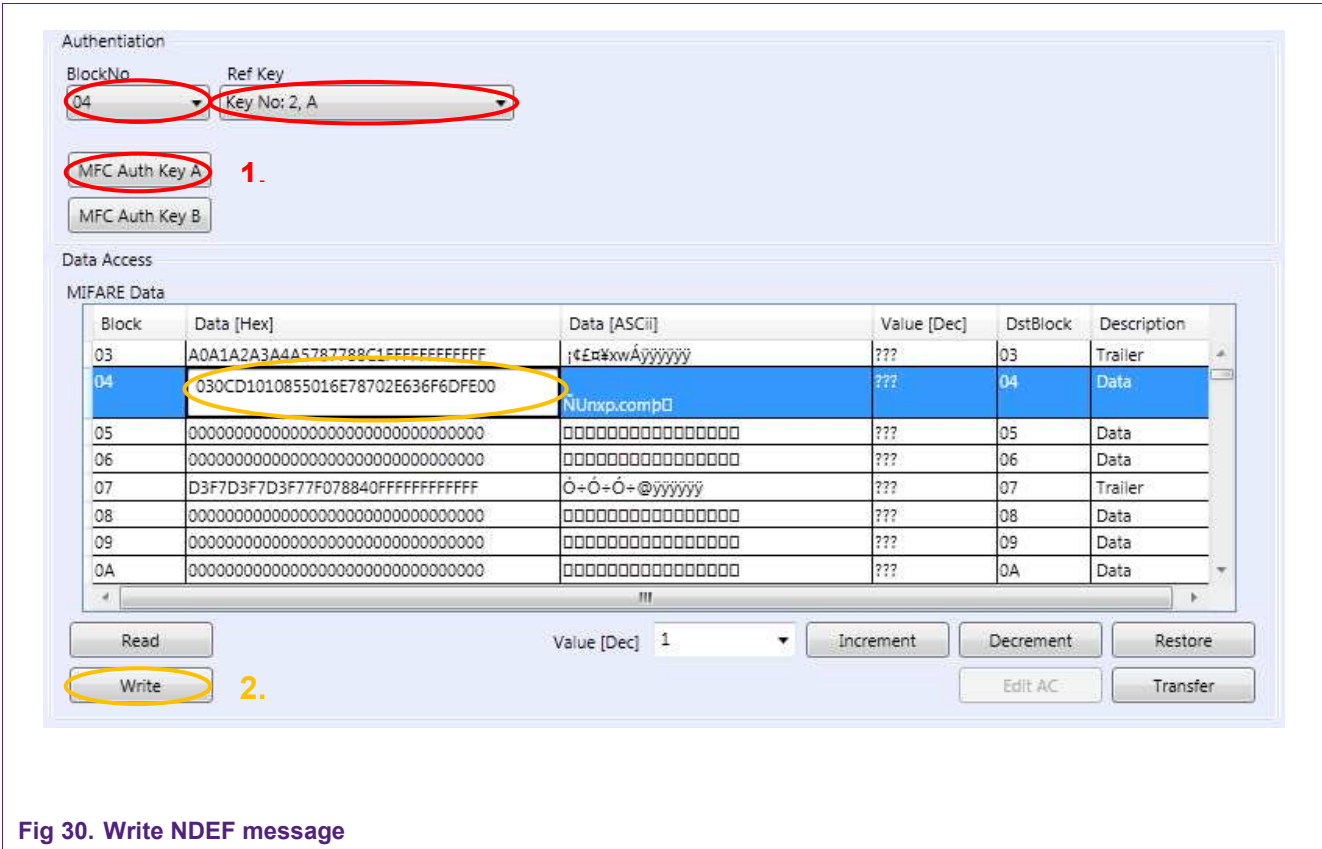


Fig 29. Set Sector Keys

5.3.2.5 Write NDEF Message

Last step is to write the actual NDEF message to the card.

1. Authenticate with BlockNo 04 with Key A (Key No: 2, A) and push 'MFC Auth Key A'
2. Write '030CD1010855016E78702E636F6DFE00' (see 5.3.1) to Block 04 and



push 'Write'

The procedure is now finished and you can use e.g. a NFC enabled Mobile to test the configured NFC Tag.



**5.3.3 MIFARE Ultralight as NFC Tag**

This is a short explanation how to use the MIFARE Ultralight as an NFC Tag Type 2 [21] store an NDEF message on the card. The used message contains the URL: <http://www.nxp.com>.

**5.3.3.1 Default factory settings MIFARE Ultralight**

The first three pages (00 – 02) are used for the UID, some internal data and the lock bits of the memory. They are read-only. Therefore you start writing at Page 03. Page 03 is only 'one time programmable'.

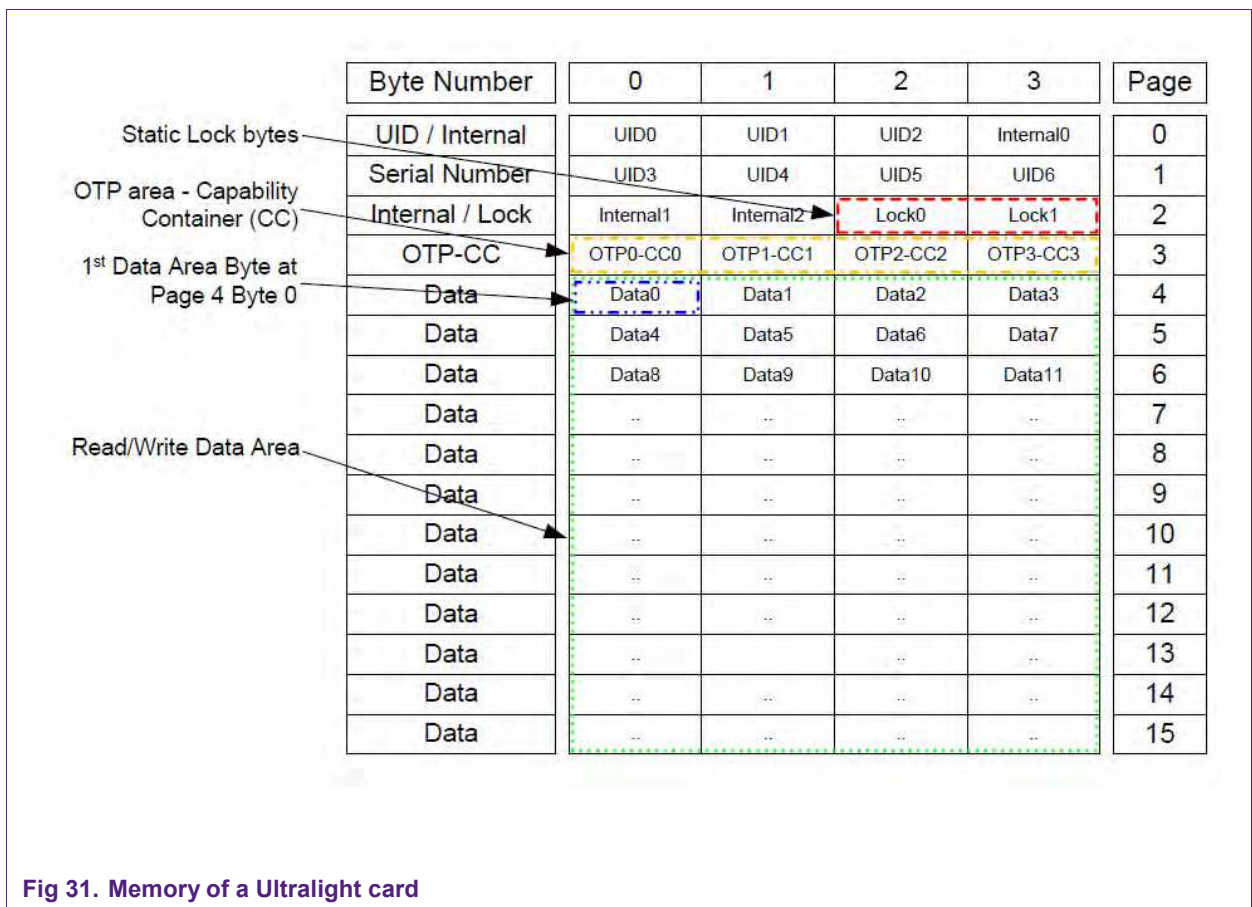


Fig 31. Memory of a Ultralight card

Every page is made of 4 bytes.

On page 02 Byte 2 and 3 need to be set to '00 00', else you cannot write or read. For details refer to [21].

**5.3.3.2 Activate TAG**

To activate the Card use the MIFARE Ultralight Tab and push the 'Activate Idle' button as shown in Fig 25.

### 5.3.3.3 Write NDEF Message

First step is to set the so called CC (Capability Container) located at page 03.

Please NOTE that once you set a bit to logic 1 in this area, it cannot be changed back to 0 anymore (xor operation).

Select the 'Ultralight' command window as shown in figure Fig 32.

1. Pick 'Page No' 03 and press the 'Read' button.
2. Write 'E1100600' into the Data textbox and push 'Write'.

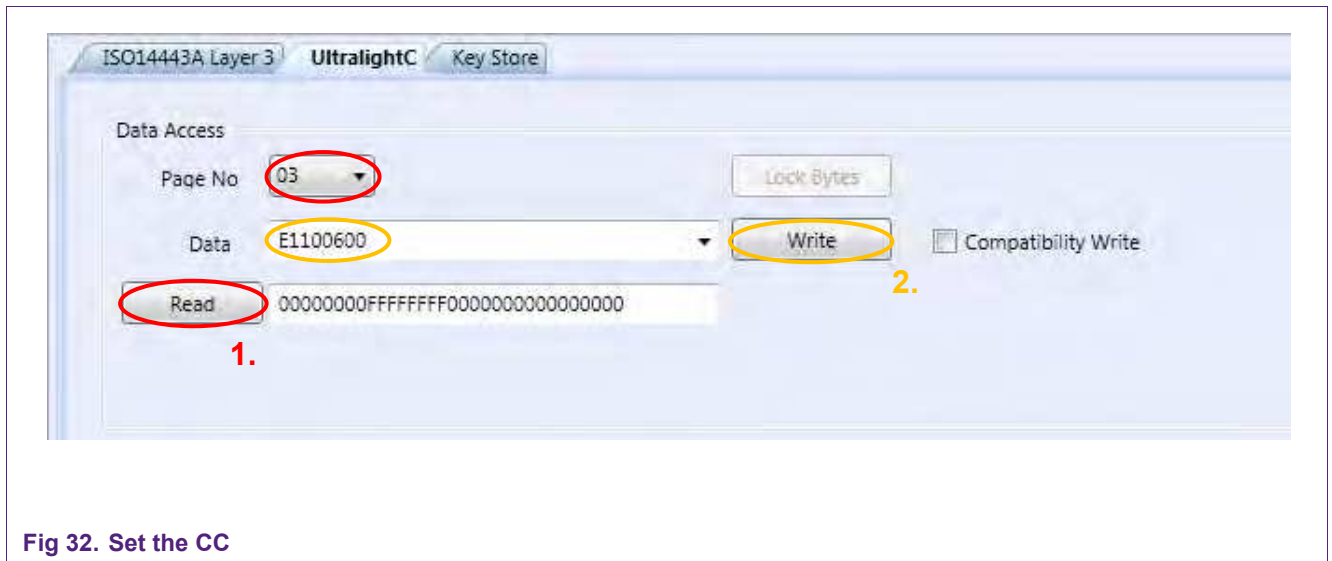


Fig 32. Set the CC

Now the NDEF message can be written to the tag. Therefore:

1. Pick 'Page No' 04
2. tackle the 'Compatibility Write' box
3. Write '030CD1010855016E78702E636F6DFE00' (the HEX coded NDEF message) and click 'Write'

The procedure is now finished and you can use e.g. a NFC enabled Mobile to test the configured NFC Tag.

## 6. Full Version

### 6.1 Starting MIFAREdiscover

Connect RD710 Reader to the PC with USB cable. Choose the desired DIP switch configuration on the mainboard of the reader (see figure 9). This can be

- Reader in X-Mode for RD710 with MIFARE SAM inserted in the slot
- Reader in No SAM-Mode
- Reader in S-Mode

In the following descriptions we need to have the DIP switch of the Pegoda set to X-Mode.

Start MIFAREdiscover from the Start menu.

You will be asked to select your reader connected to MIFARE AV2 SAM as shown in Fig.15.

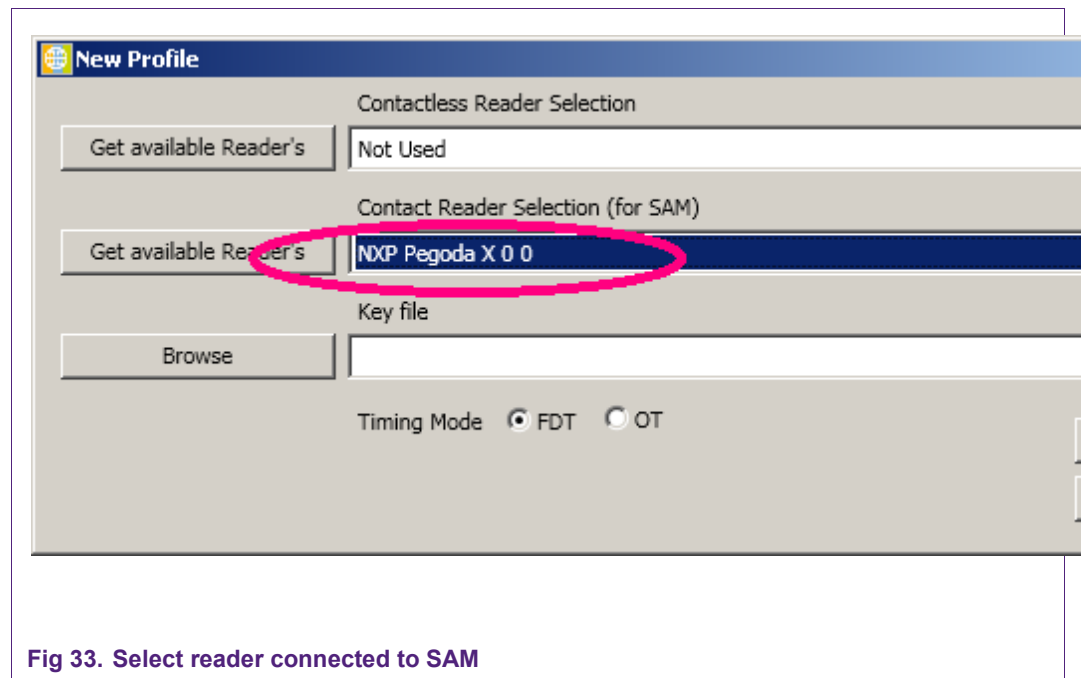


Fig 33. Select reader connected to SAM

Select the reader. Any time the profile can be closed or opened by using close and open profile respectively.

After selection of the reader the key file can be browsed if it is necessary. In the key file, the secret keys can be stored, which may be needed to authenticate MIFARE SAM AV2 with the host or to be changed later. Press OK button to validate the profile. If the MIFARE SAM AV2 is connected properly, the status field of the history window shows "SUCCESS".

### 6.2 User Interface Overview

There are 5 areas in the main window, as shown in Fig 16.

1. Menu Bar and Buttons: for reader connection, display settings and help
2. Command Selection Window: list of commands
3. Configuration Window: for detailed configurations of commands
4. History Window: Showing the command execution histories
5. Status Bar: Showing the current command execution status

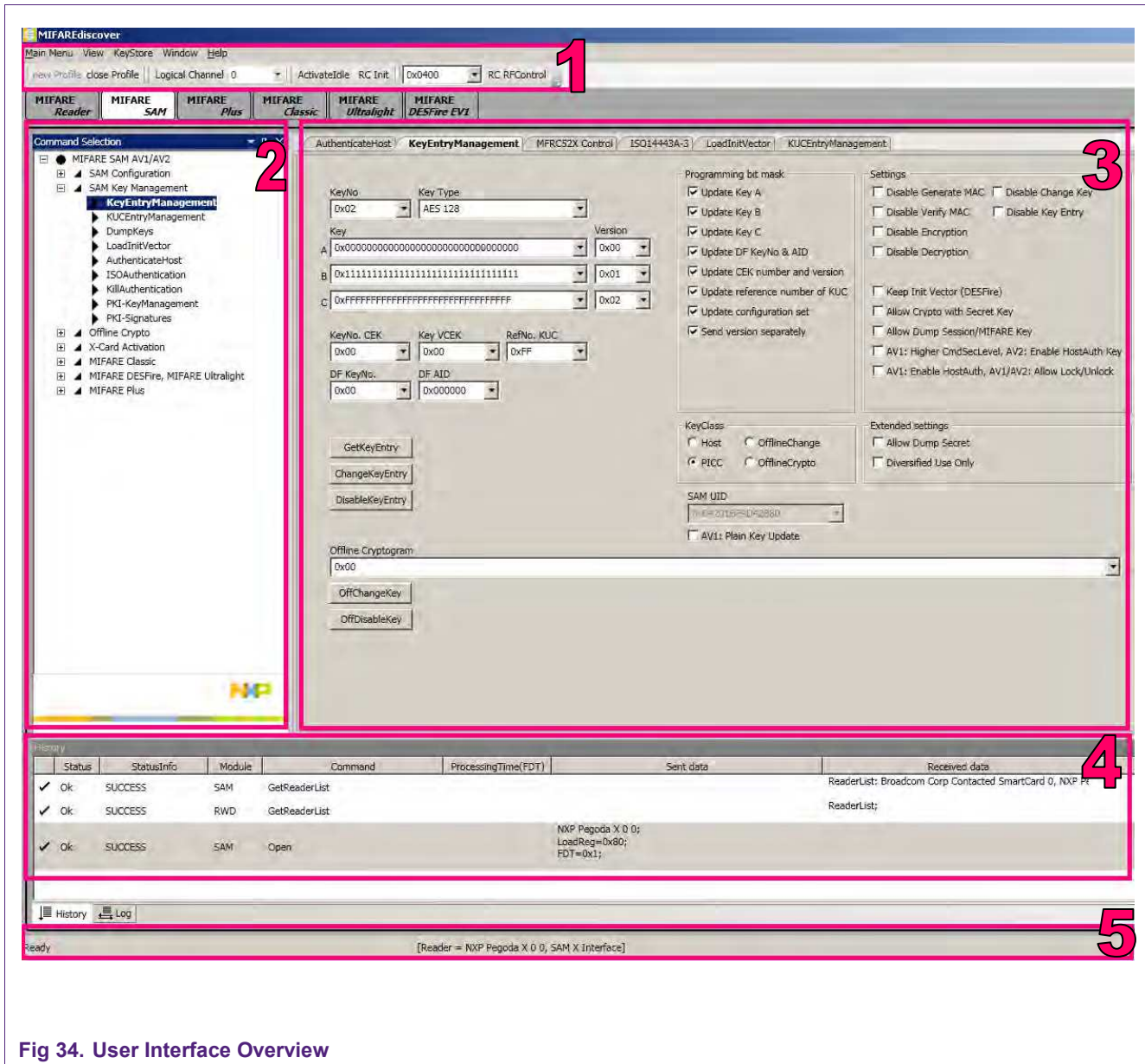


Fig 34. User Interface Overview

## 7. Examples of some use cases for the full version

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In every use case (defined below) we need to have the DIP switch of the Pegoda reader set to **X-Mode**.

### Overview

#### 7.1. Checking the connected MIFARE SAM AV2

Here you will get some hardware and software related information about the installed SAM.

#### 7.2. Switch the MIFARE SAM from AV1 to AV2 Mode

AV2 mode is recommended because of security reasons.

#### 7.3. Authenticate host

This step is needed when operating with the SAM.

#### 7.4. Operating the MIFARE DESFire EV1

##### 7.4.1. Using MIFARE SAM AV2 for communication with MIFARE DESFire EV1

This example shows how to perform a basic authentication between SAM and MIFARE DESFire EV1.

##### 7.4.2. Create Application and format MIFARE DESFire

##### 7.4.3. Authenticate Application

#### 7.5. Operating the MIFARE Plus S

##### 7.5.1. Switch MIFARE Plus from Security Level 0 in Security Level 1

Security level 0 is the initial delivery configuration of the PICC. We have to pre-personalize the card to get into security level 1.

##### 7.5.2. Switch MIFARE Plus from Security Level 1 in Security Level 3

Because security level 1 is the compatibility mode to the MIFARE Classic card, we want to use the enhanced security of security level 3.

##### 7.5.3. Read/Write Actions of MIFARE Plus in Security Level 3

A short introduction of how to access blocks with read and write operation in security level 3.

### 7.1 Checking the connected MIFARE SAM AV2

Ensure that the Pegoda reader is set to “X-Mode”.

Let’s check the connected MIFARE SAM AV2. It can be done using the GetVersion command.

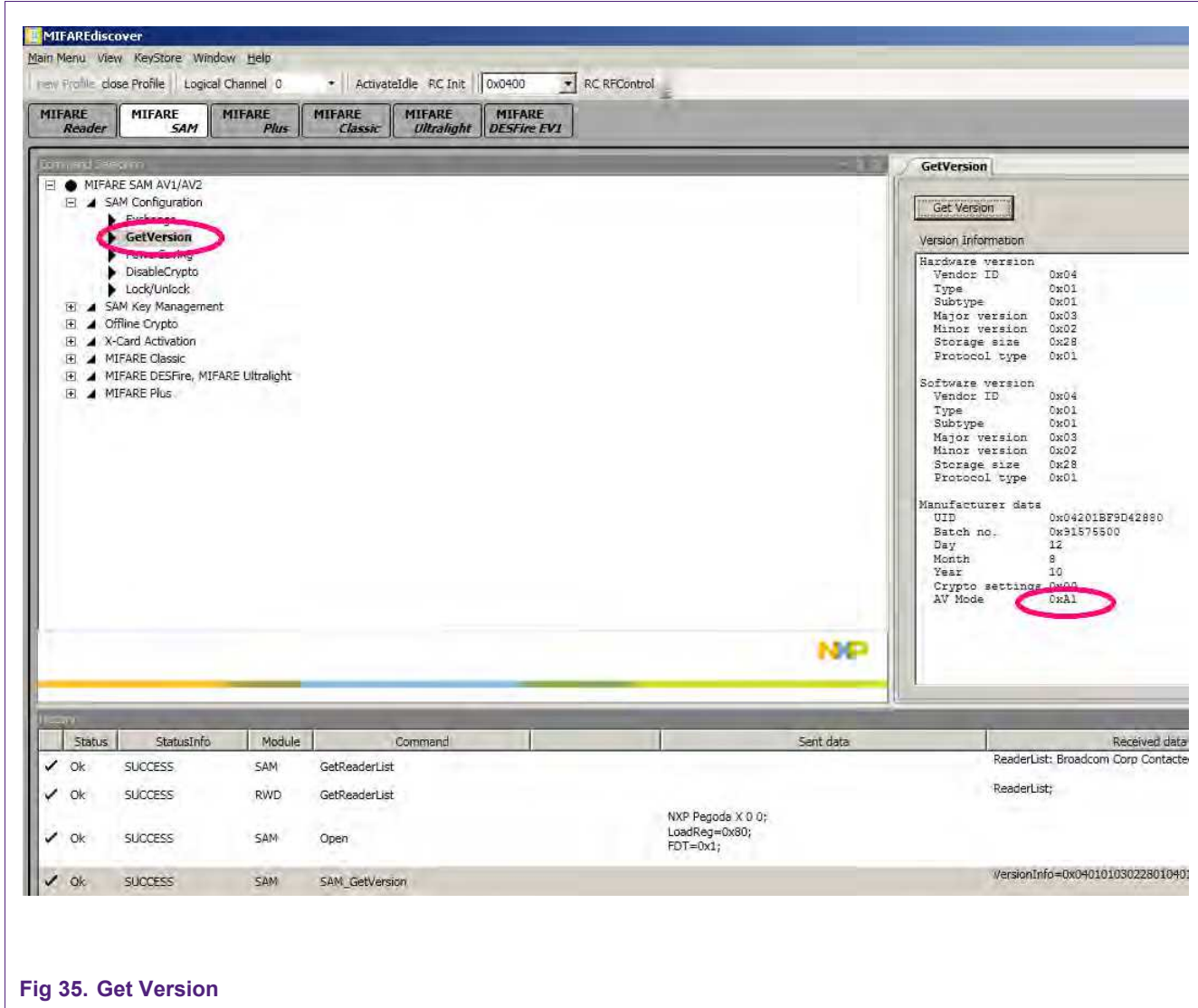


Fig 35. Get Version

The last byte of the “GetVersion” response will be “0xA1” for MIFARE SAM AV1 and will be “0xA2” for MIFARE SAM AV2.

### 7.2 Switch the MIFARE SAM from AV1 to AV2 Mode

The default MIFARE SAM is delivered from NXP semiconductor in MIFARE SAM AV1 mode. DIP switches should be set to “X-Mode” (see figure 9). For switching to AV2 mode follow the steps.

### 7.2.1 Authenticate host

Select the “AuthenticateHost” command at the command window. Set the reference key as shown in the following figure. The reference key here used is “Key No: 0, A” for the default setting, where you need to authenticate host using SAM Master key entry and version “00” to change the key.

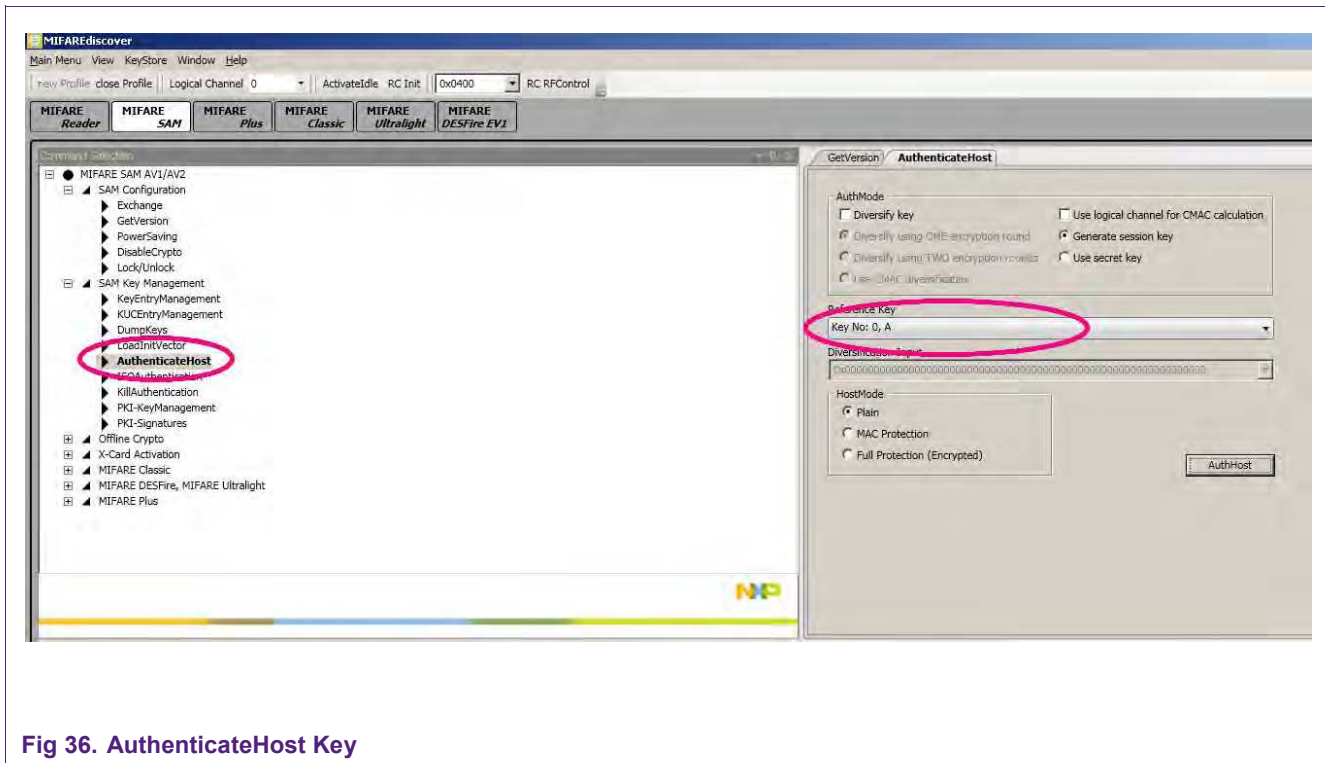


Fig 36. AuthenticateHost Key

### 7.2.2 Change SAM Master key to AES

SAM master key entry has to be changed to AES type to be able to switch the SAM mode.

Select the “KeyEntryManagement” Command from the command window and set the key “00” and key type “AES 128” (AES 192 is also ok). Set other field as shown in the following figure. We take the new key values and version all 00s, if you want, you can make your own keys as you like.

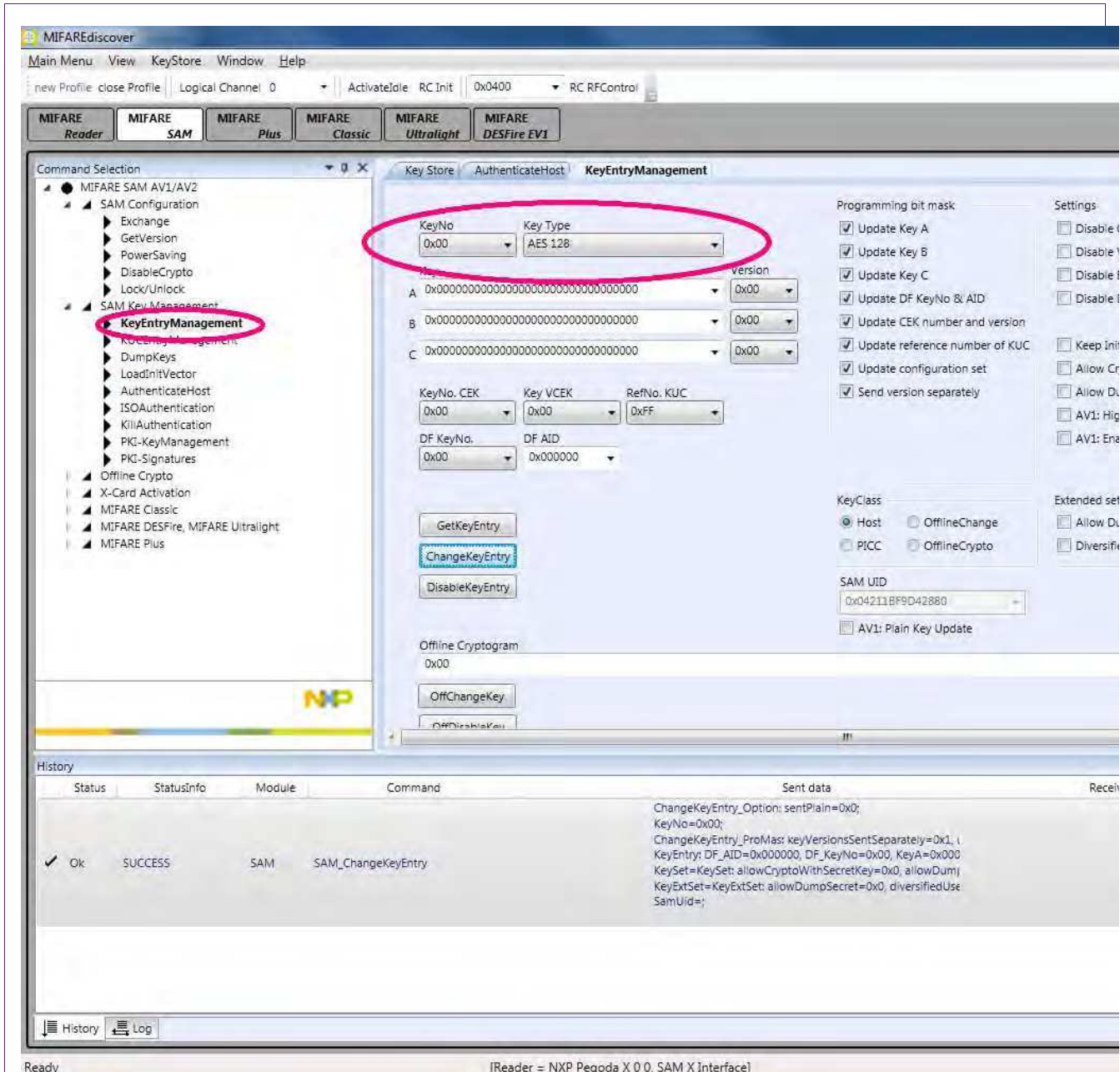


Fig 37. Change SAM master key to AES



If the SAM master key is already AES key type the steps 7.2.1 and 7.2.2 are not required.

Now change the key entry in the key file to have the same key as we have in the MIFARE SAM. Open the key file from menu. Change the key type and key values as we downloaded in previous command.

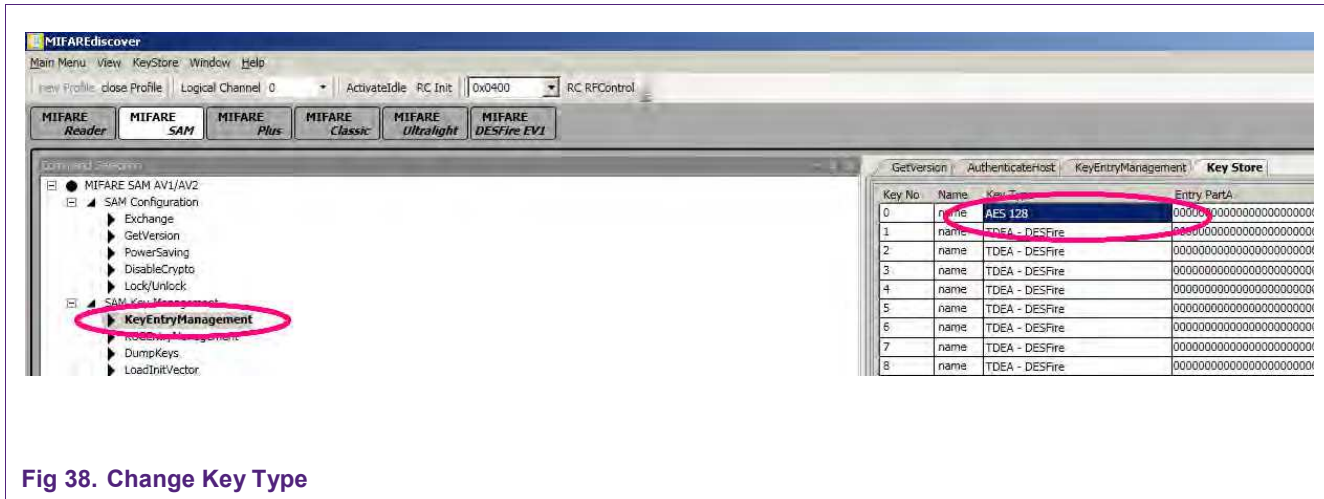


Fig 38. Change Key Type

7.2.3 Lock/Unlock Command

Now the MIFARE SAM AV2 is ready to accept the Activation of AV2 mode command.

Select the "Lock/Unlock" Command from the command window. Set the mode to "Activate AV2 mode" and refer to the key "key no: 0, A" of the key file as shown in the following figure, figure 21.

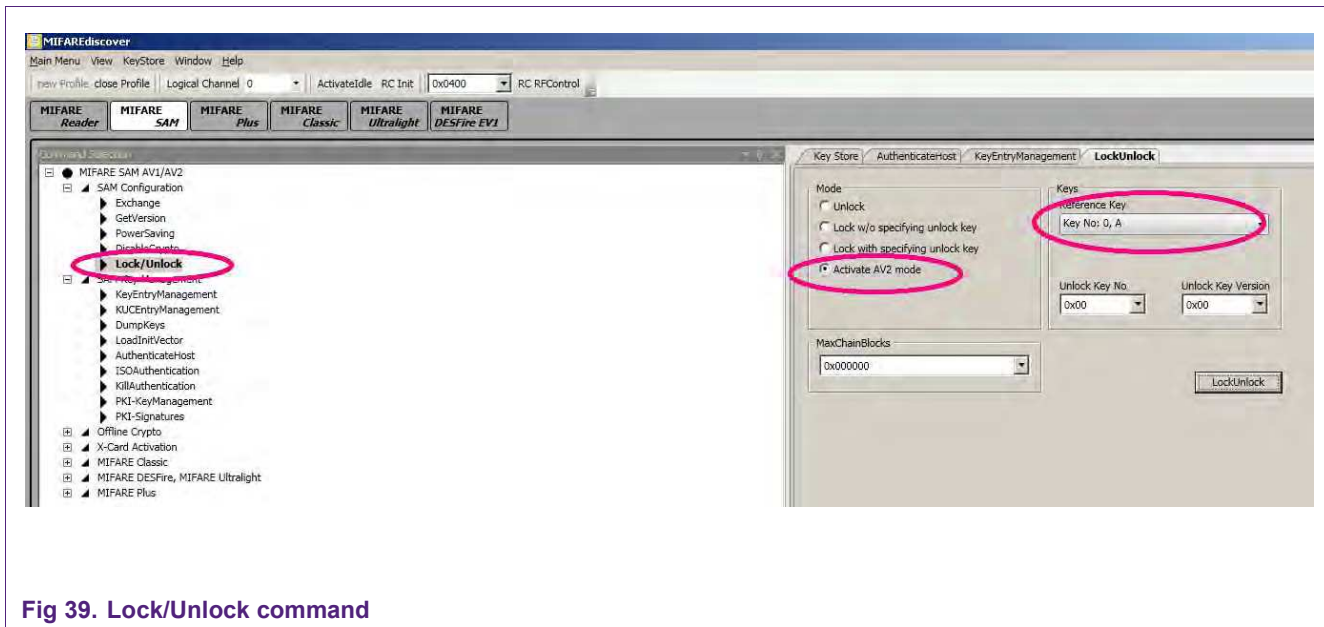


Fig 39. Lock/Unlock command

Now the MIFARE SAM is switched to AV2 mode.

### 7.3 Authenticate Host

Ensure that the Pegoda reader is set to “X-Mode”.

Select the “AuthenticateHost” command at the command window and open the Key Store Manager.

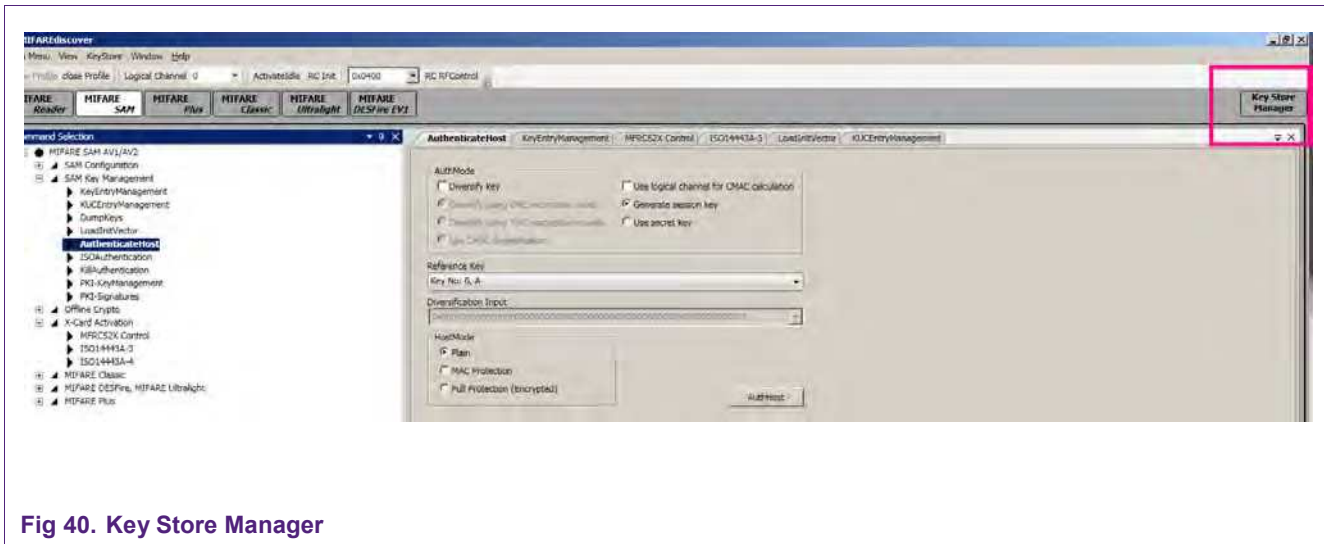


Fig 40. Key Store Manager

Change the settings:

KeyNo: 0, Key Type: AES 128, Part A: 00000000000000000000, VersionA: 00

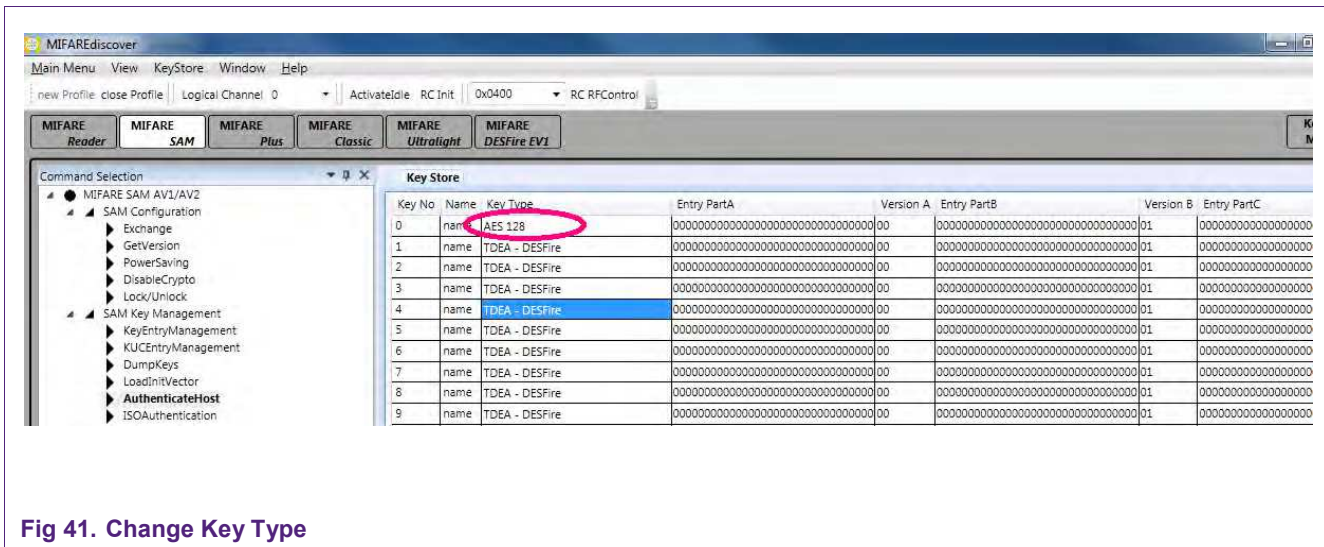


Fig 41. Change Key Type

Leave the Key Store manager and select “AuthenticateHost” again. Be sure to tick “Generate session key” at the AuthMode section and “Plain” at HostMode. Click “AuthHost”.

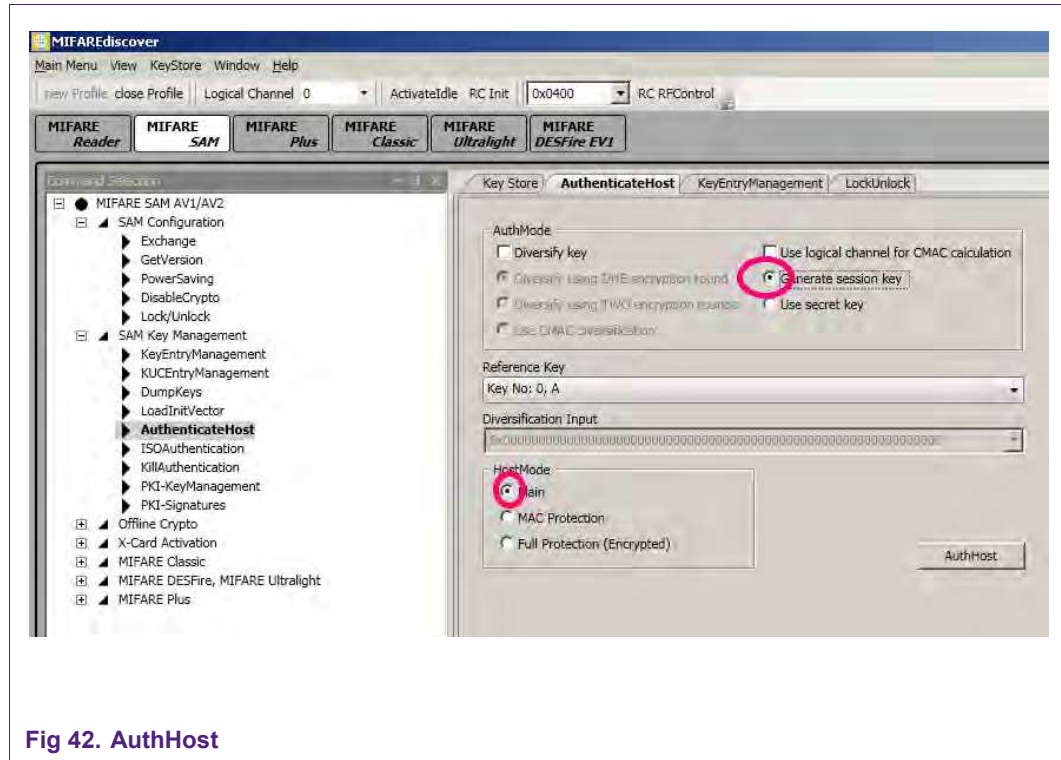


Fig 42. AuthHost

### 7.4 Operating the MIFARE DESFire EV1

The MIFARE DESFire EV1 answers every command with a status code. These codes can be found in MIFAREdiscover command selection at the Received data column. For example, if you enter an invalid command you will get “AppDataOut=0x1C”.

A list with useful status and error codes is provided:

Table 3. Useful status and error codes

Hex Code	Status
0x00	OPERATION_OK
0x0C	NO_CHANGES
0x0E	OUT_OF_EEPROM_ERROR
0x1C	ILLEGAL_COMMAND_CODE
0x1E	INTEGRITY_ERROR
0x40	NO_SUCH_KEY
0x7E	LENGTH_ERROR
0x9D	PERMISSION_DENIED
0x9E	PARAMETER_ERROR
0xA0	APPLICATION_NOT_FOUND
0xA1	APPL_INTEGRITY_ERROR
0xAE	AUTHENTICATION_ERROR
0xAF	ADDITIONAL_FRAME
0xBE	BOUNDARY_ERROR

Hex Code	Status
0xC1	PICC_INTEGRITY_ERROR
0xCD	PICC_DISABLED_ERROR
0xCE	COUNT_ERROR
0xDE	DUPLICATE_ERROR
0xEE	EEPROM_ERROR
0xF0	FILE_NOT_FOUND
0xF1	FILE_INTEGRITY_ERROR

**7.4.1 Using MIFARE SAM AV2 for communication with MIFARE DESFire EV1**

At first, the DESFire Key has to be downloaded to the MIFARE SAM if it is not already there. According to the steps done here, downloading a key to the MIFARE SAM requires host authentication as shown in § 7.3.

**7.4.1.1 Uploading MIFARE DESFire EV1 AES key to SAM**

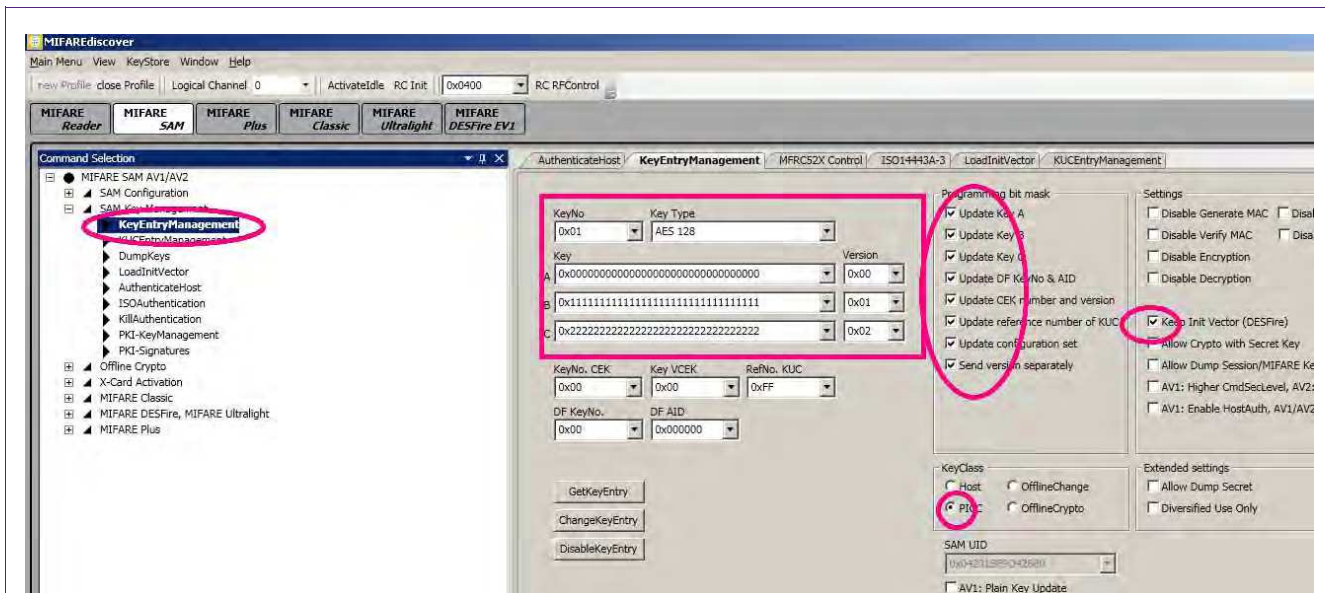
Let’s change the key entry number 1 to PICC DESFire EV1 AES key. To make it simple

Key A = “00000000000000000000000000000000”, version 0x00

Key B = “11111111111111111111111111111111”, version 0x01

Key C = “22222222222222222222222222222222”, version 0x02

The other options are checked as shown in the following figure, figure 25.



**Fig 43. Downloading MIFARE DESFire EV1 AES key to SAM**

Do not forget to tick the “keep Init Vector” option for DESFire EV1 AES and standard TDEA keys.

7.4.1.2 Accessing MIFARE DESFire EV1

The steps are as follows:

1. RC Init to initialize the I<sup>2</sup>C communication (shown in fig. 26).
2. RC RFControl to turn on the RF field (shown in fig. 26).

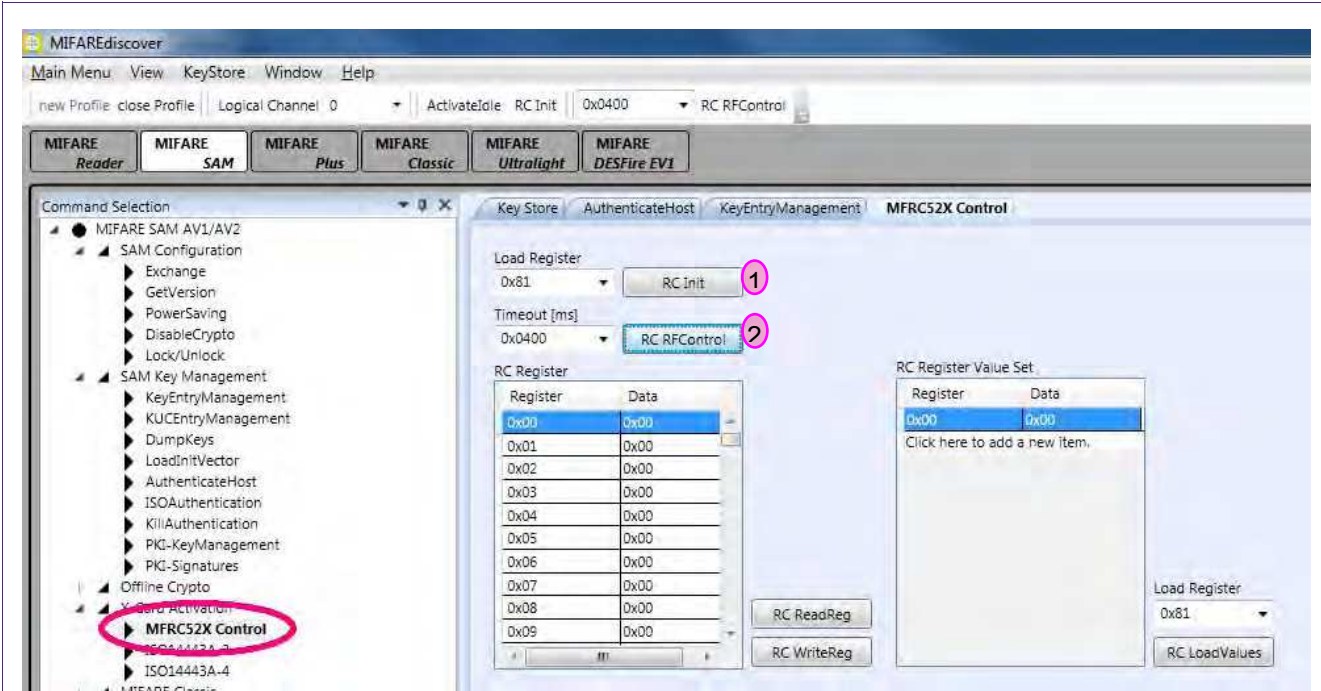


Fig 44. RC Init and RC RF Control

3. Activateldle to activate the MIFARE DESFire EV1 card to ISO/IEC14443 part 3 (shown in fig. 27).
4. RATS and PPS command to prepare the MIFARE DESFire EV1 card to ISO/IEC 14443-4 layer (shown in fig. 28).

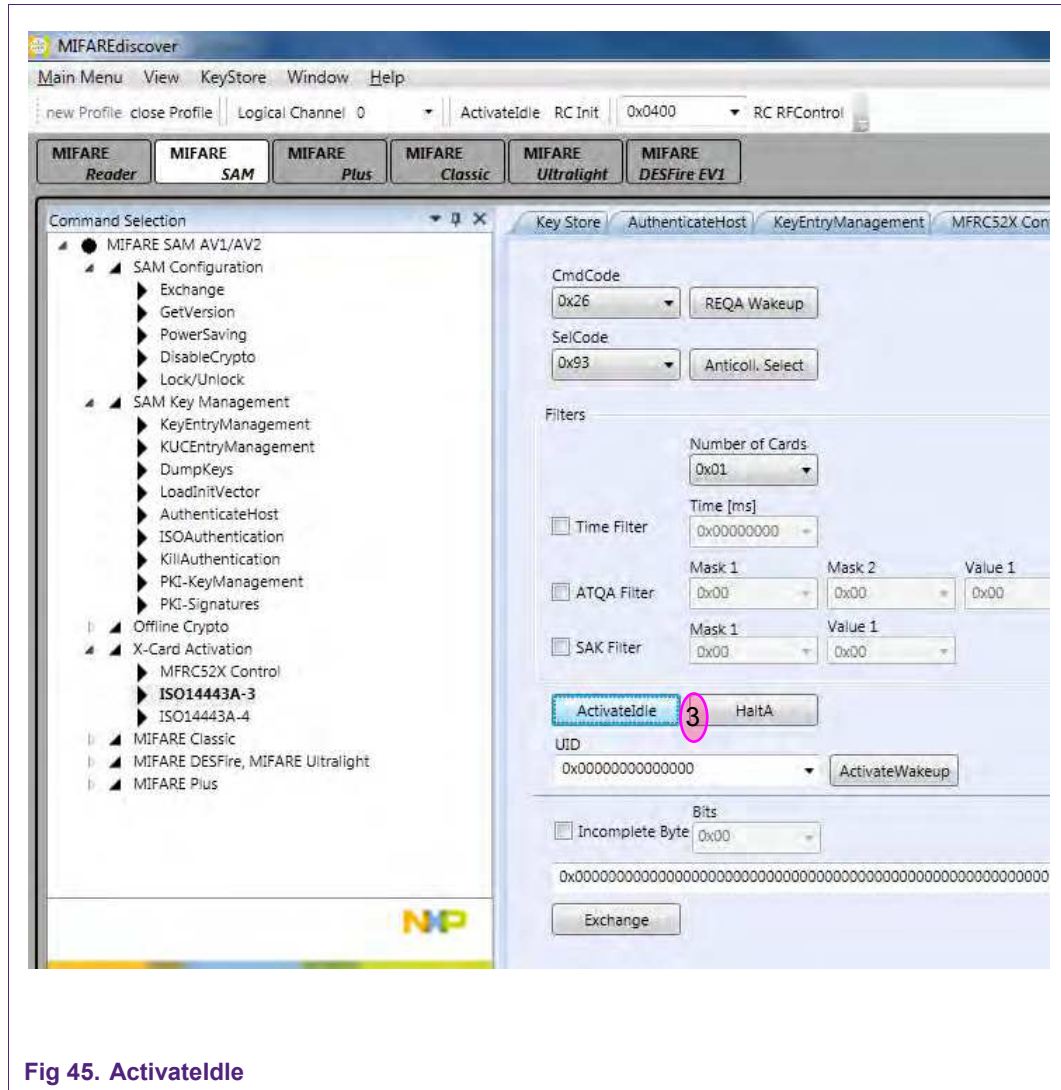


Fig 45. ActivateIdle

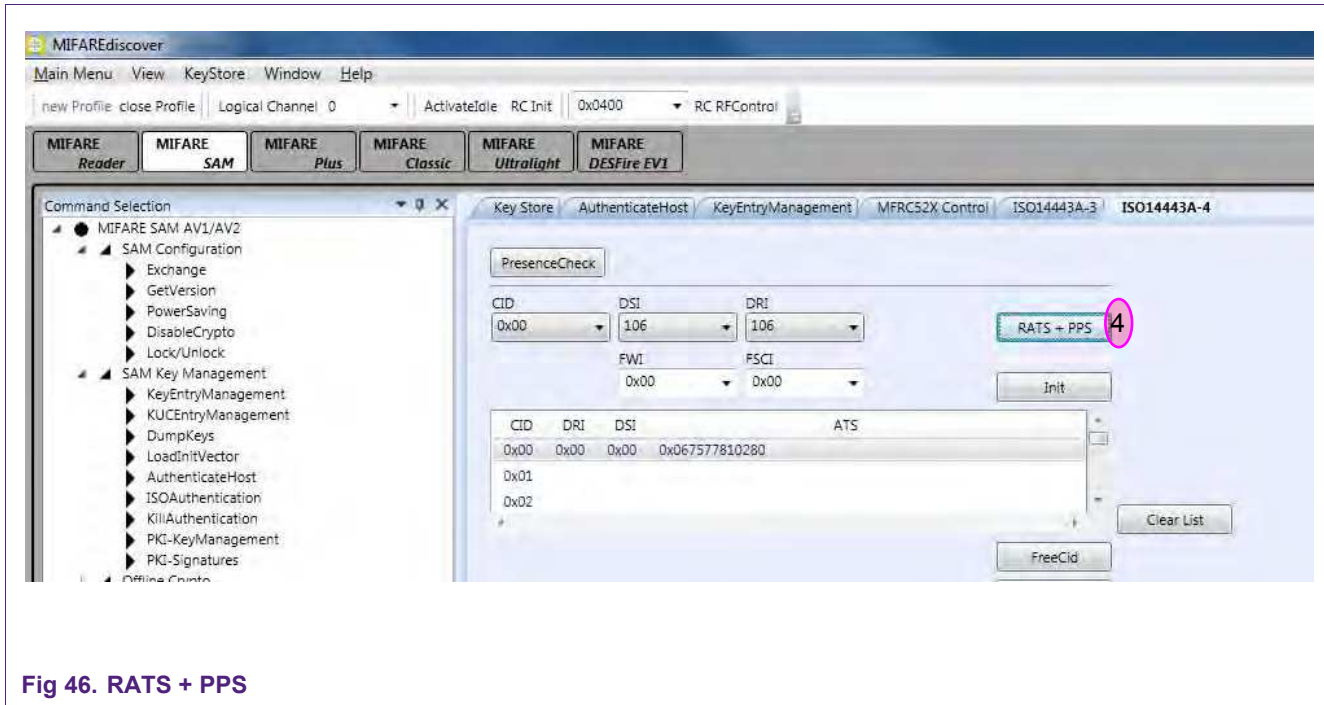


Fig 46. RATS + PPS

Sometimes, when opening RD710 with MIFARE SAM AV2 for the first time, ReqA and ActivateIdle commands fail. As a workaround, please execute the following steps.

Select “SAM Configuration” and “Exchange” at the Command Selection window and insert the following data:

CLA = 0x80, INS = 0x2E, P1 = 0x00, P2 = 0x00, Lc = 0x16

Tick „Use Data“

Data: 2A822BAA15401875194D265927F4283F29110C100100

And press “Exchange”.

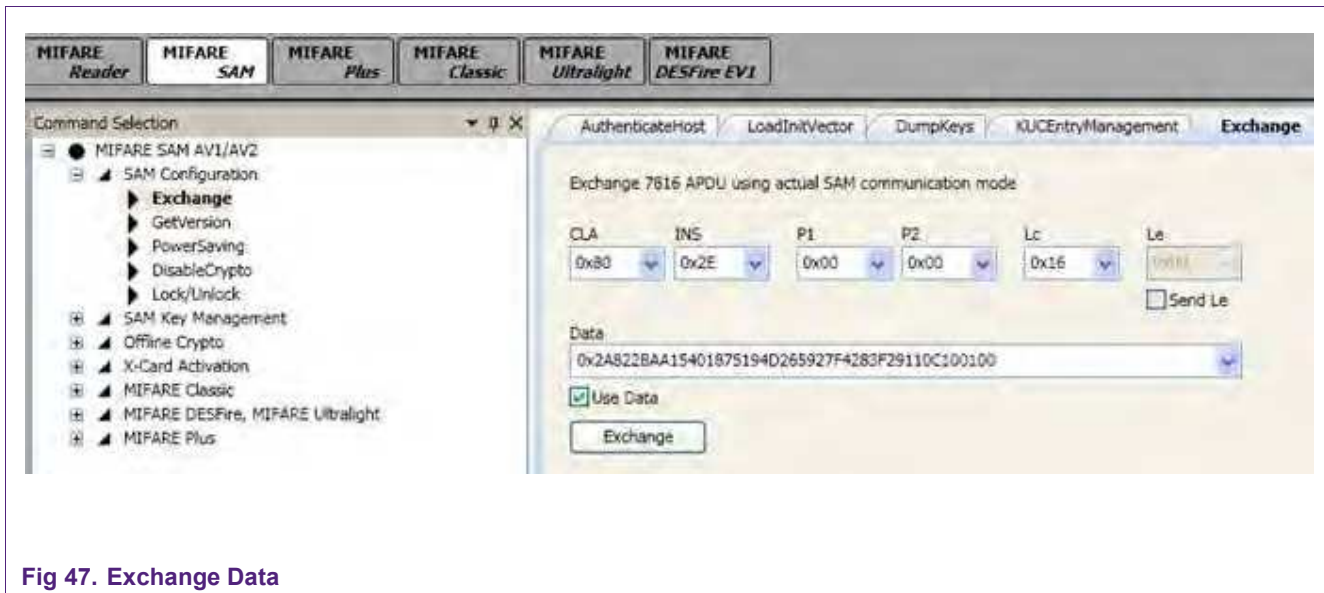


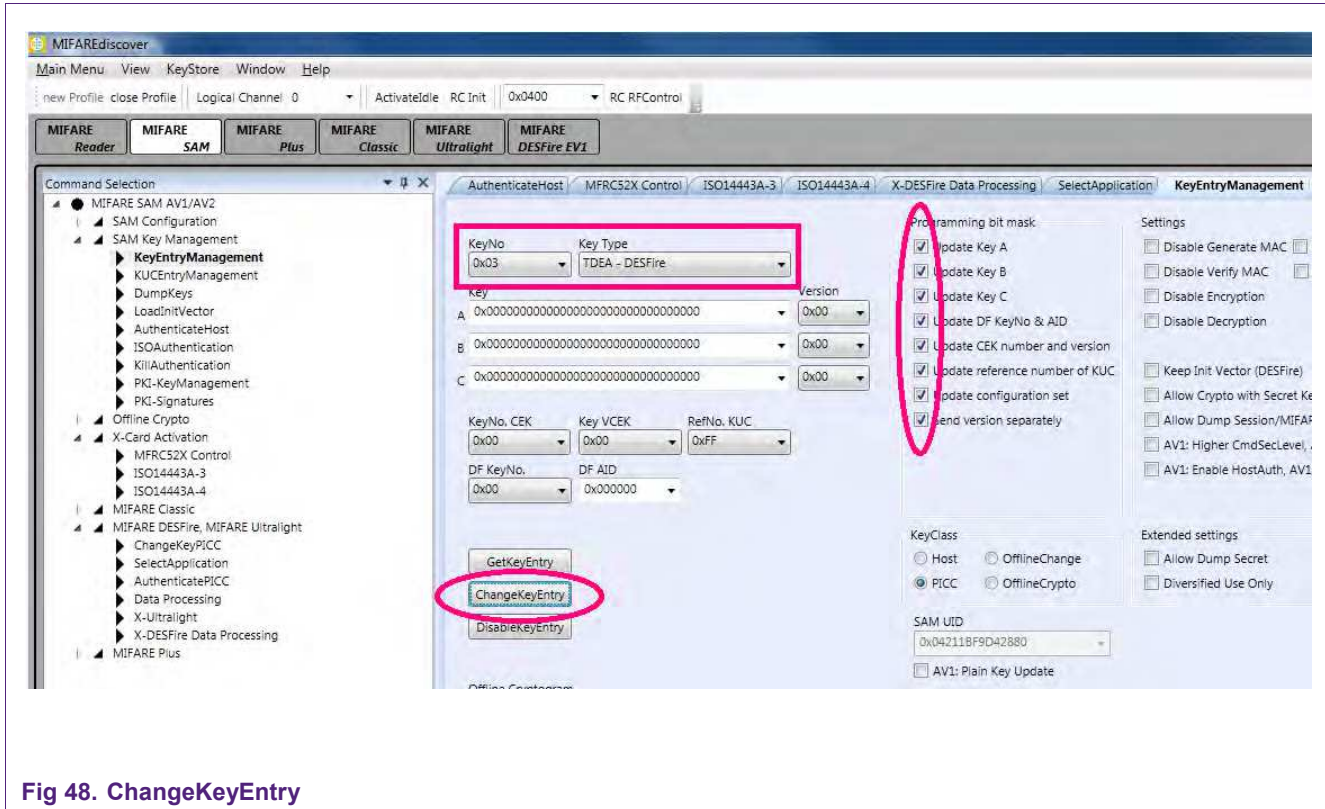
Fig 47. Exchange Data



**7.4.2 Create Application and format MIFARE DESFire**

1. See § 7.3 and do the AuthenticateHost command
2. Open the “KeyEntryManagement” and change the Master Key to KeyNo: 03 if it is still “default”. The Key Type has to be TDEA – DESFire.

All Keys and Versions are 0, KeyClass is PICC. Be sure to tick everything at Programming bit mask (see figure below).



**Fig 48. ChangeKeyEntry**

3. Click “ChangeKeyEntry”
2. To get access to DESFire, do the steps described in § 7.4.1.2.
3. Then select “X-DESFire AID Data Processing” at the Command Selection and insert the following data:

DESFire KeyNo:0  
 “Selection by key entry number”  
 Mode: Native  
 Current Key KeyNo: 0x03, KeyVersion 0x00

4. Click “AuthPICC”.

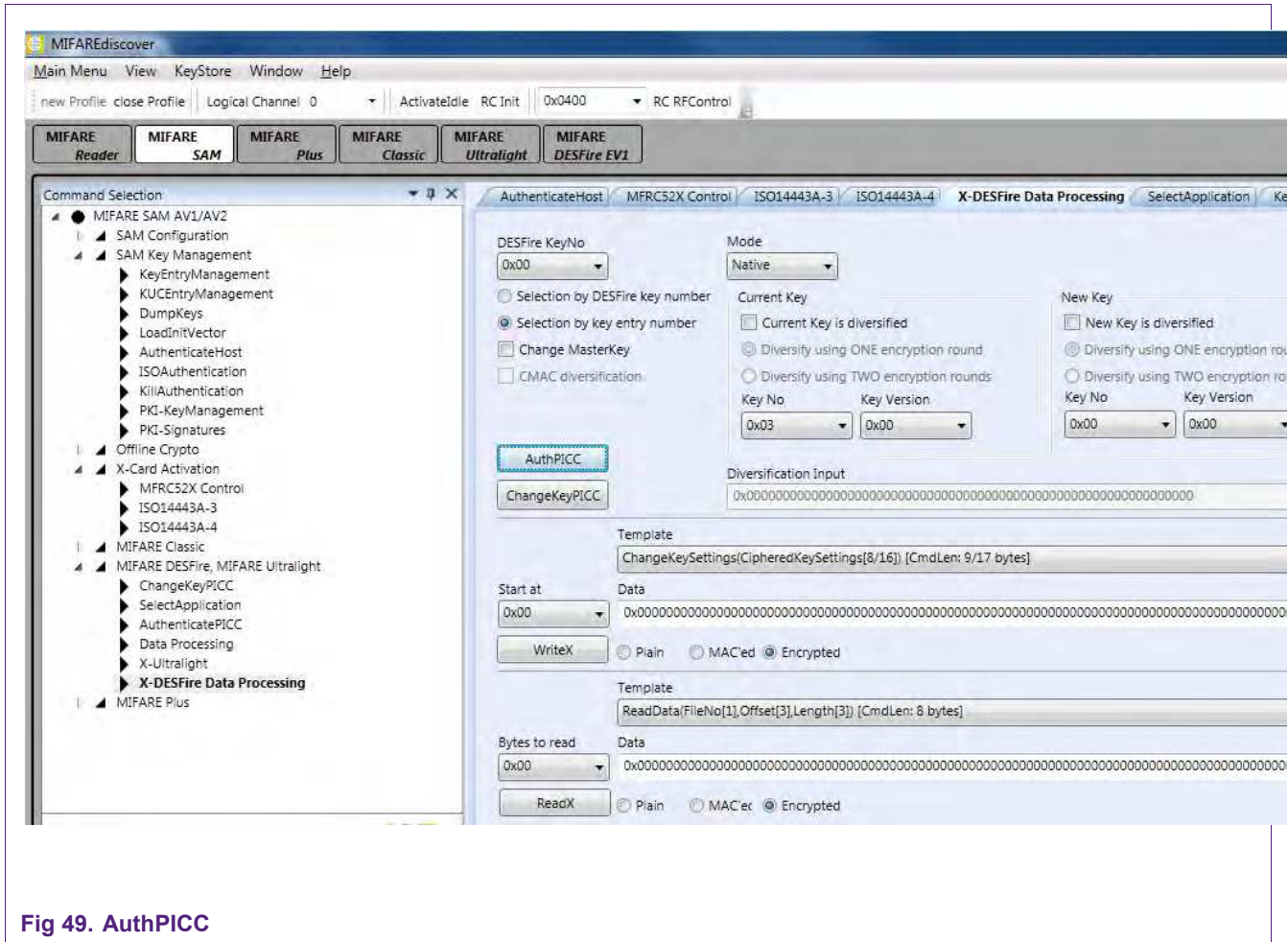


Fig 49. AuthPICC

5. Go to "ISO14443A-4".
6. To see applications on the card, insert "0x6A" and click "Exchange".  
 To create a new application, insert "0xCaaaaaa0f8e" and click "Exchange" (The repeated "a" describe the AID (Application ID))  
 To format the card, insert "0xfc" and click "Exchange".

7.4.3 Authenticate Application

1. Do the ApplicationHost command, as described in § 7.3.
2. Open the “KeyEntryManagement” and change the Master Key to “KeyNo: 01” if it is still “default”. The Key Type has to be AES 128.

All Keys and Versions are 0, KeyClass is PICC. Be sure to tick everything at Programming bit mask and “Keep Init Vector (DESFire)”.

3. Click “ChangeKeyEntry”
4. To get access to DESFire, do the steps described in § 7.4.2.
5. Select Application with “5aaaaaaa” and click “Exchange”.

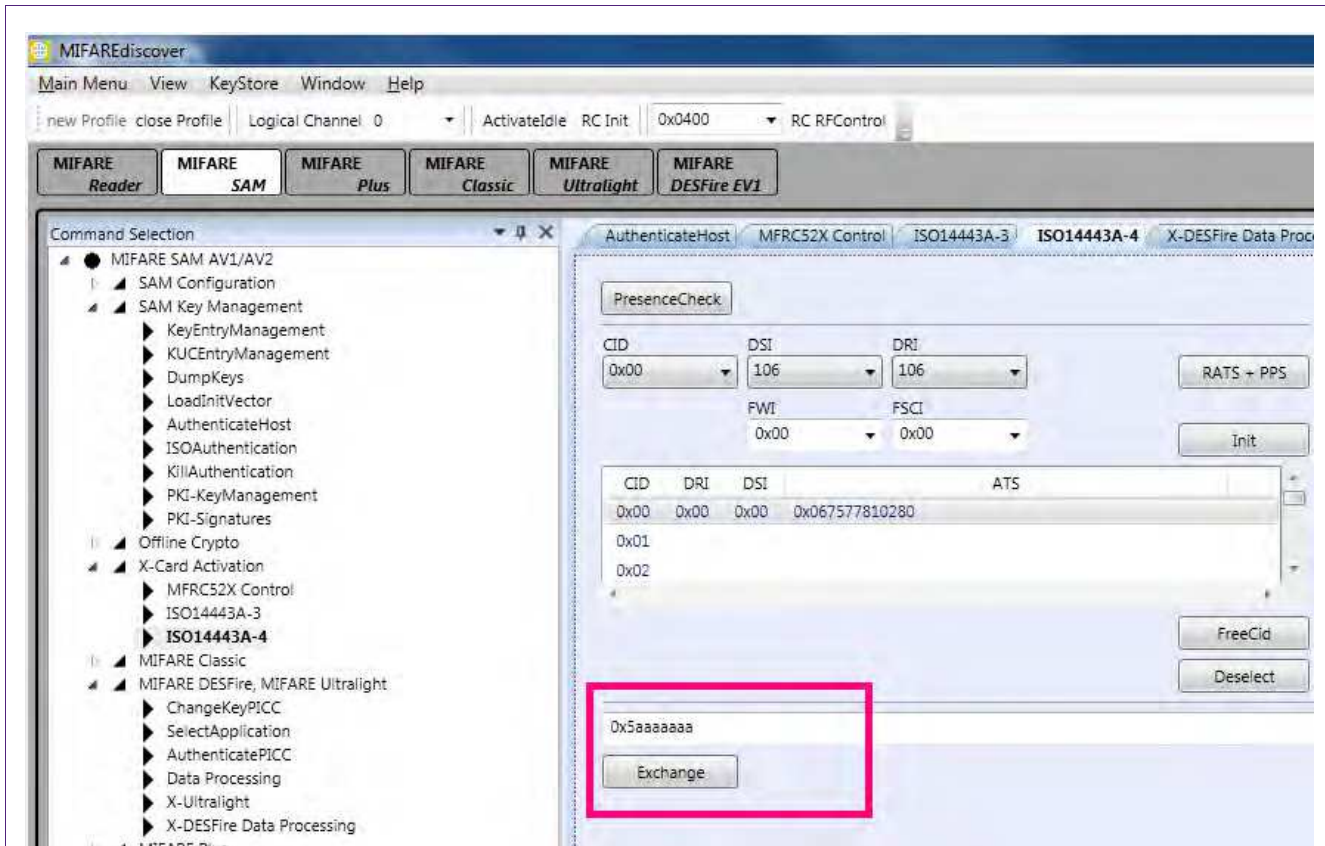


Fig 50. Select Application

6. Select “X-DESFire Data Processing” at the Command Selection
7. Insert the following data:

DESFire KeyNo: 1

"Selection by key entry number"

Mode: Native

Current Key: Key No.: 01, Key Version: 0

8. Click “AuthPICC”.

Now you are registered with your first Application.

### 7.5 Operating the MIFARE Plus S

To get to MIFARE Plus, you have to set the DIP switches to X-mode (see figure 9) and switch the MIFARE SAM into AV2 mode.

#### 7.5.1 Switch MIFARE Plus from Security Level 0 in Security Level 1

Select “MIFARE Plus” (below the Menu bar) and then “ISO14443A Layer 3” at the command selection. Click “RF Reset” first and “Activate Idle” afterwards.

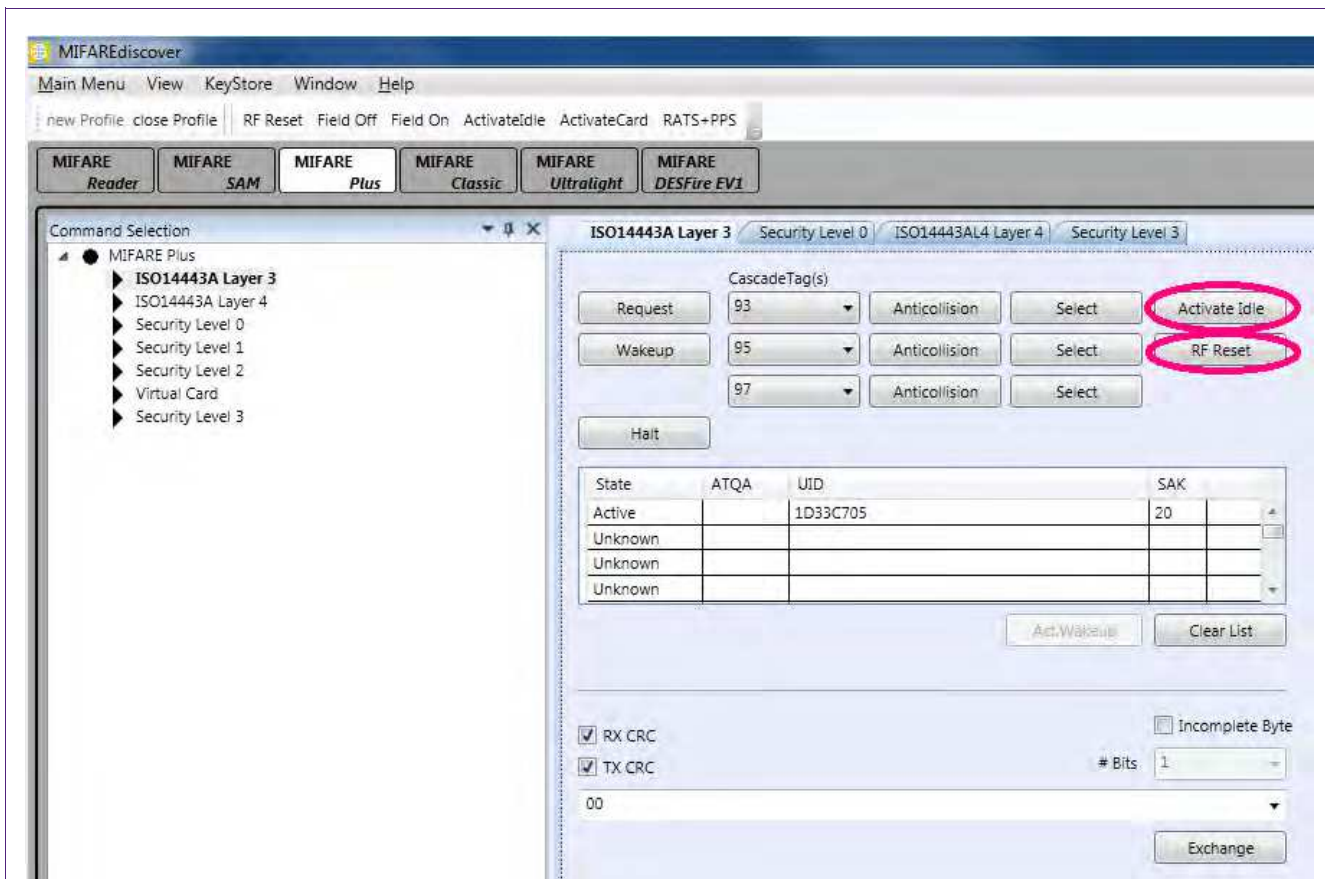


Fig 51. RF Reset and ActivateIdle

Go to “ISO14443A Layer 4” and click “ActivateCard”.

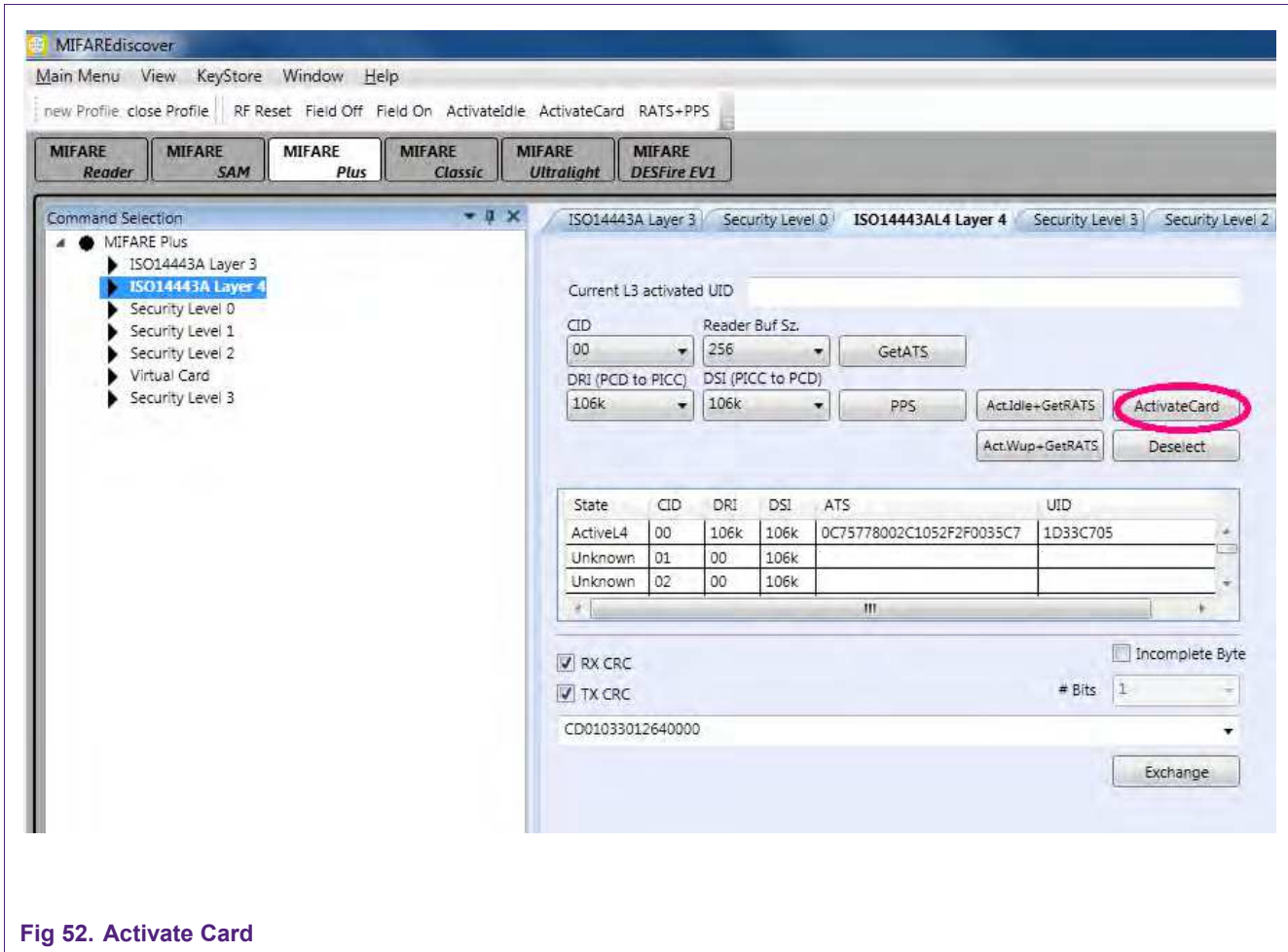


Fig 52. Activate Card

Select "Security Level 0" at the Command selection and insert the data as the next figure shows:

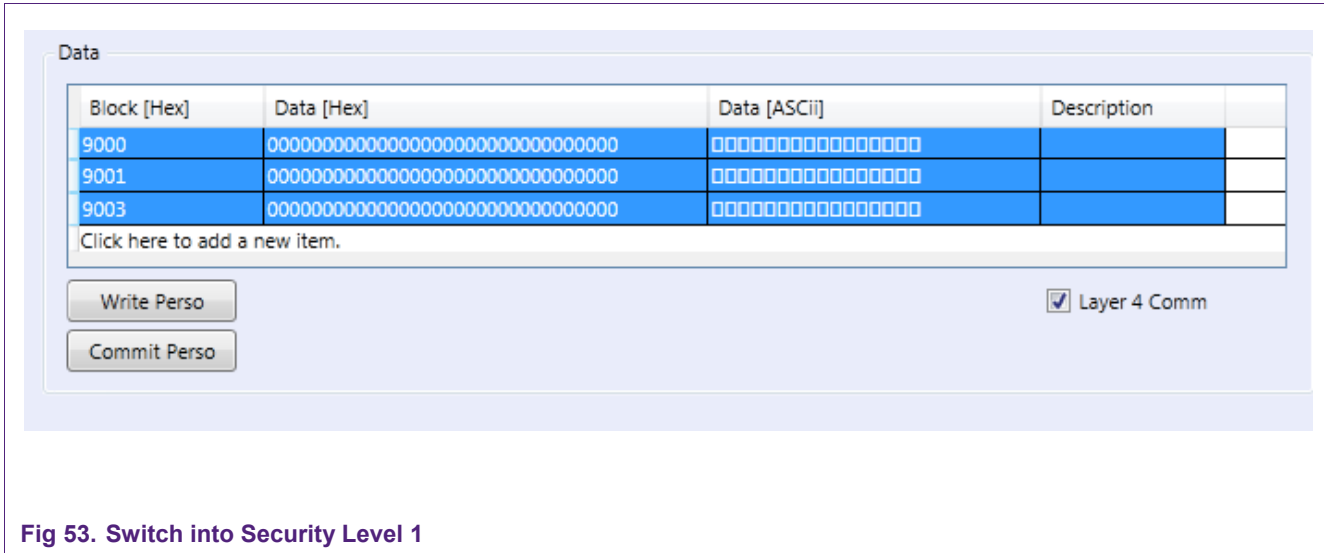


Fig 53. Switch into Security Level 1

Press Ctrl on your keyboard to select all 3 entries. Then click "Write Perso" and afterwards "Commit Perso".

Then, press the following buttons (Menu bar) in this sequence: "RF Reset", "Activateldle", "ActivateCard".

Now, your card is in Security Level 1.

### 7.5.2 Switch MIFARE Plus from Security Level 1 in Security Level 3

After switching MIFARE Plus into Security Level 1, it is now possible to switch to Security Level 3.

Select “Security Level 1” at the Command selection and change the settings as shown in the following figure. Click “FirstAuth” after you are done.

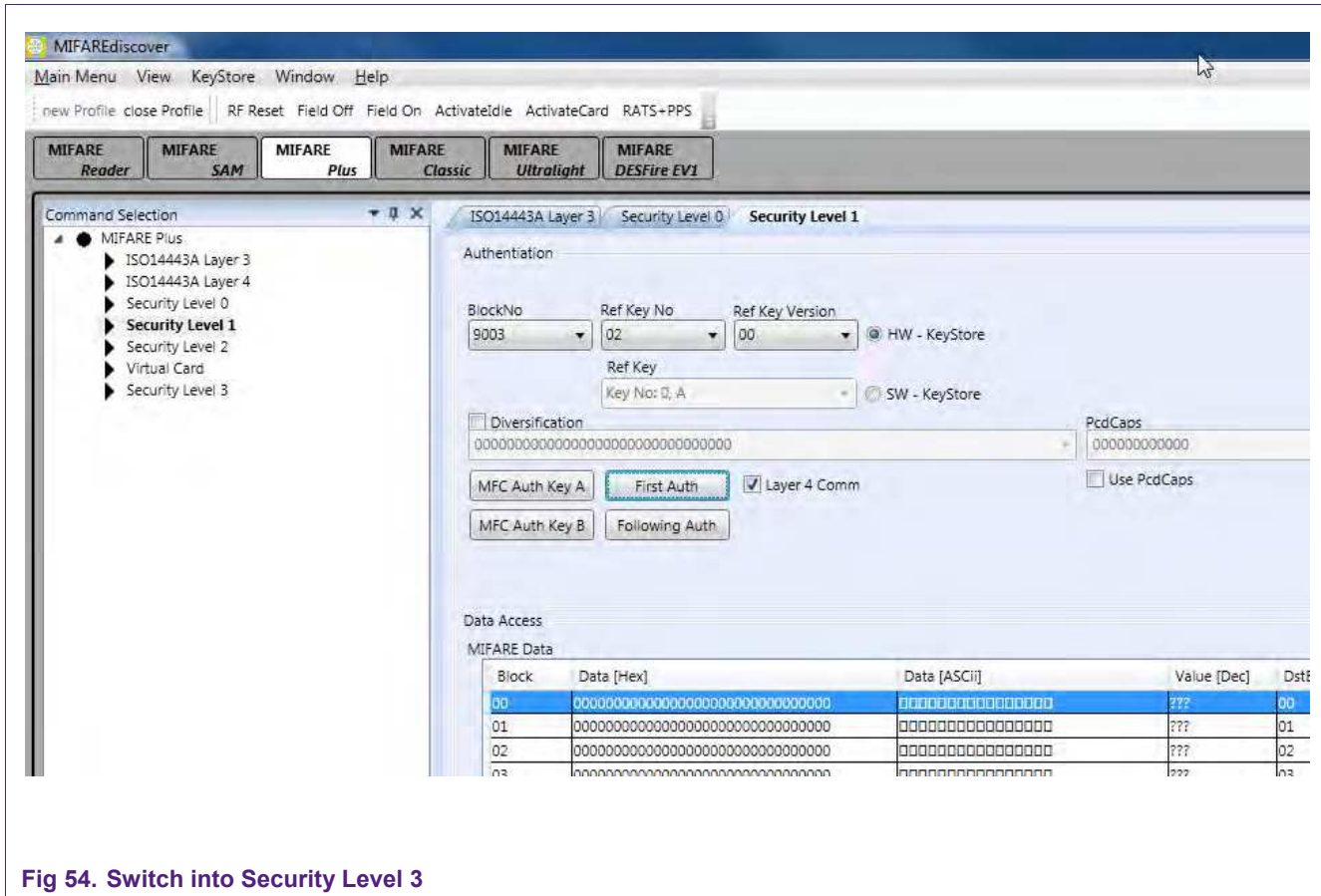


Fig 54. Switch into Security Level 3

Now your card is in Security Level 3.

You can check if the MIFARE Plus is in security level 3 by performing an “ActivateIdle” command. At the section “Received Data” in the command history you will see the SAK of the card afterwards. For example, if you have a 4KB MIFARE Plus card you will get 0x20 if it is in Security Level 3. See the Application note AN10833 for details. ([http://www.nxp.com/documents/application\\_note/AN10833.pdf](http://www.nxp.com/documents/application_note/AN10833.pdf))

### 7.5.3 Read/Write Actions of MIFARE Plus in Security Level 3

Select “Security Level 3” at the Command selection.

Because the standard key for the blocks are the same as we inserted at the keystore at position 02, version 02, we can now use these to authenticate at different storage locations.

Change the settings:

Block/KeyNo: 4000

Ref Key No: 02

Ref Key Version: 02

“HW – KeyStore”

And click “FirstAuth”

If you click “Read” you can now read the individual blocks and if you click “Write” you can write beforehand edited blocks. Be sure to tick “MAC on Command” and “MAC on Response” (figure 37).

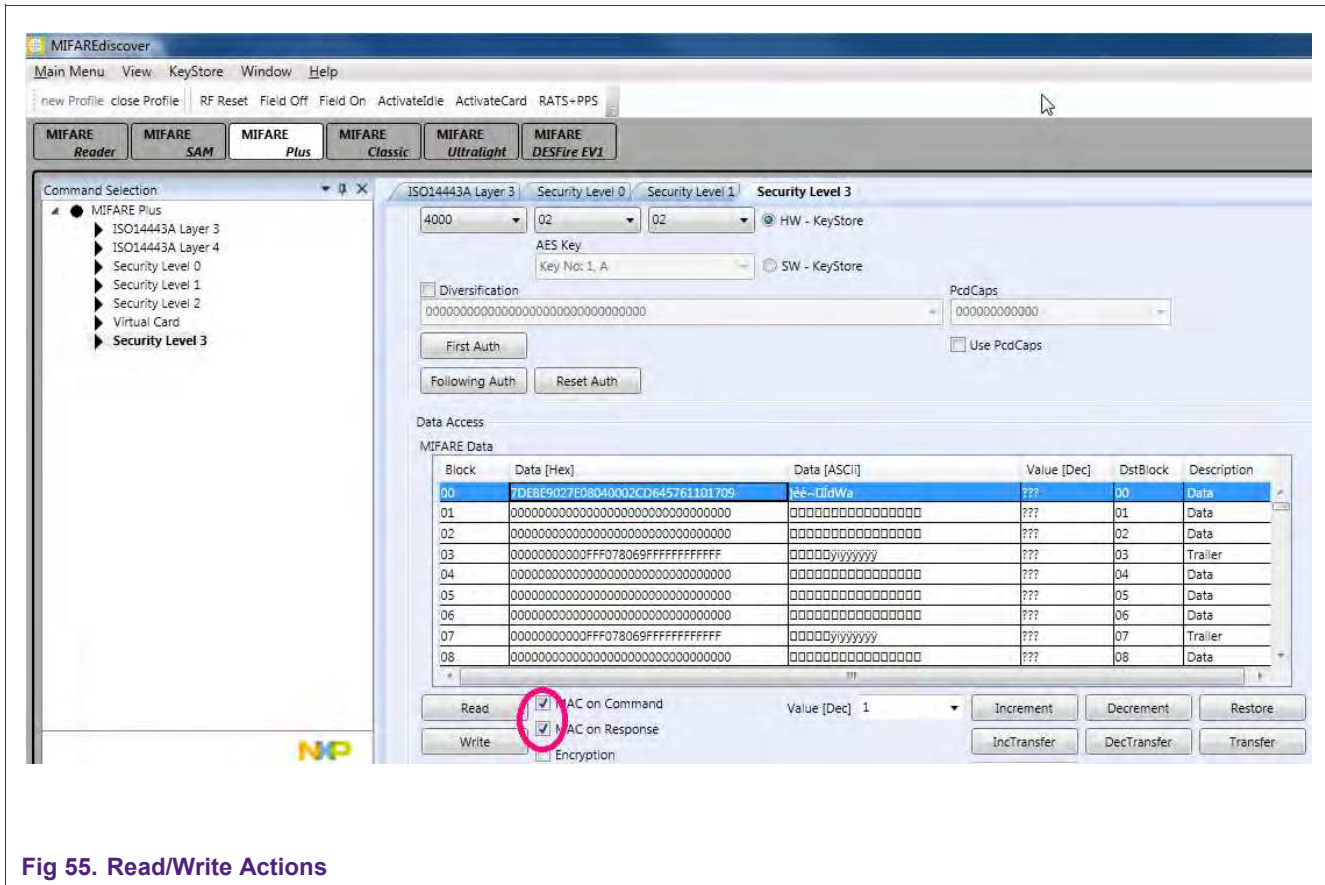


Fig 55. Read/Write Actions



## 7.6 Using MIFAREdiscover without MIFARE SAM AV2

Ensure that the Pegoda is set to „Normal Mode“.

All described accesses to MIFARE cards are also possible without the MIFARE SAM AV2. If you use a MIFARE SAM AV2 all keys that are needed to get access to MIFARE cards get stored on the SAM.

If no MIFARE SAM AV2 is used the keys have to be inserted at the Key Store Manager of MIFAREdiscover. At positions where a key is needed you have to insert “SW – KeyStore” and the suitable storage location instead of “HWKeyStore”.

## 8. Firmware download

In order to download firmware to the reader, the DIP switches have to be configured to “flash mode” as described in section 3. After a reset of the Pegoda reader it does response as mass storage device. The user can upgrade the Pegoda firmware by copying it (drag and drop) to the Pegoda mass storage device.

**Important note: The file name of the binary file must be renamed to pegoda2x.bin, where x can be any character or letter or none; otherwise the Pegoda will refuse to copy the file and Windows will response with an I/O error (see 36).**

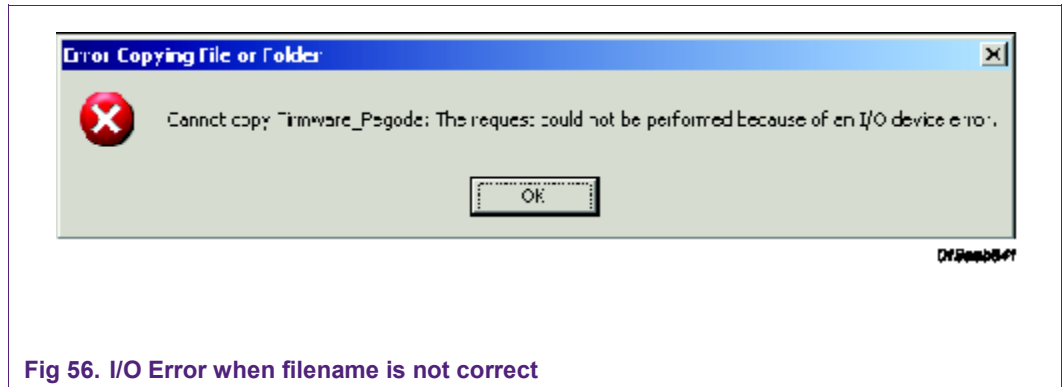


Fig 56. I/O Error when filename is not correct

After successfully copying the file, the Pegoda will start blinking and beeping; windows will response with the following message (see 37). Don't be irritated that this is a windows error dialog as well.

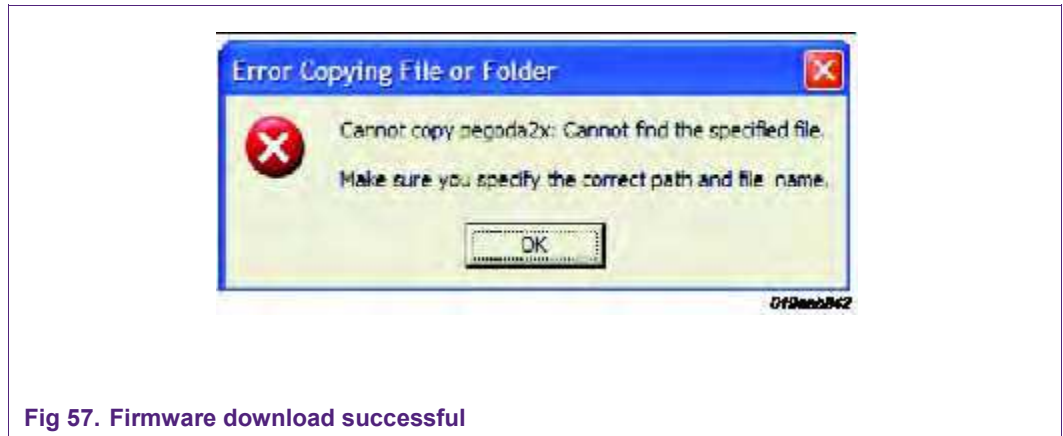


Fig 57. Firmware download successful

Now, the firmware has been updated; reset the device and choose the desired reader mode with the DIP switches.

## 9. Error Codes

In MIFAREdiscover, user will observe following error and component codes in the History window under Status Info. The definitions of the error codes will help user to understand the cause of error.

### Error codes & definitions

Error Codes	Definition
SUCCESS	Returned in case of no error
SUCCESS_CHAINING	Rx chaining is not complete, further action needed
SUCCESS_INCOMPLETE_BYTE	An incomplete byte was received
IO_TIMEOUT	No reply received, e.g. PICC removal
INTEGRITY_ERROR	Wrong CRC or parity detected
COLLISION_ERROR	A collision occurred
BUFFER_OVERFLOW	Attempt to write beyond buffer size
FRAMING_ERROR	Invalid frame format
PROTOCOL_ERROR	Received response violates protocol
AUTH_ERROR	Authentication error
READ_WRITE_ERROR	A Read or Write error occurred in RAM/ROM or Flash
TEMPERATURE_ERROR	The RC sensors signal overheating
RF_ERROR	Error on RF-Interface
INTERFACE_ERROR	An error occurred in RC communication
LENGTH_ERROR	A length error occurred
INTERNAL_ERROR	An internal error occurred
INVALID_DATA_PARAMS failed)	Invalid data parameters supplied (layer id check
INVALID_PARAMETER	Invalid parameter supplied
PARAMETER_OVERFLOW overflow	Reading/Writing a parameter would produce an
UNSUPPORTED_PARAMETER	Parameter not supported
UNSUPPORTED_COMMAND	Command not supported
USE_CONDITION	Condition of use not satisfied
KEY	A key error occurred

## Component codes & Identifiers

Component Code	Identifiers
GENERIC	Generic Component Code
BAL	BAL Component Code
HAL	HAL Component Code
PAL_ISO14443P3A	ISO14443-3A PAL-Component Code
PAL_ISO14443P3B	ISO14443-3B PAL-Component Code
PAL_ISO14443P4A	ISO14443-4A PAL-Component Code
PAL_ISO14443P4	ISO14443-4 PAL-Component Code
PAL_MIFARE	MIFARE(R) PAL-Component Code
PAL_FELICA	Open FeliCa PAL-Component Code
PAL_EPCUID	ICode EPC/UID PAL-Component Code
PAL_SLI15693	ICode SLI/ISO15693 PAL-Component Code
PAL_I18000P3M3	ISO18000-3 Mode3 PAL-Component Code
PAL_I18092MPI Code	ISO18092 passive initiator mode PAL-Component
AL_MFC	MIFARE(R) Classic AL-Component Code
AL_MFUL	MIFARE(R) Ultralight AL-Component Code
AL_MFP	MIFARE(R) Plus AL-Component Code
AL_VCA	Virtual Card Architecture AL-Component Code
AL_FELICA	Open FeliCa AL-Component Code
AL_I15693	ISO15693 AL-Component Code
AL_SLI	ICode SLI AL-Component Code
AL_I18000P3M3	ISO18000-3 Mode3 AL-Component Code
AL_MFDF	MIFARE DESFIRE EV1 AL Component Code
AL_P40CMDPRIV	P40 command libraryAL-Component Code
AL_P40CMDPUB	P40 command libraryAL-Component Code
DL_AMP	Amplifier DL-Component Code
DL_THSTRM	Thermostream DL-Component Code
DL_OSCI	Oscilloscope DL-Component Code
DL_RDFFPGA	Reader FPGA Box DL-Component Code
DL_MSTAMPOSC	Master Amplifier Oscilloscope DL-Component Code
DL_STEPPERStepper	DL-Component Code
CIDMANAGER	Cid Manager Component Code
CRYPTOSYM	CryptoSym Component Code
KEYSTORE	KeyStore Component Code

TOOLS

Tools Component Code

CRYPTORNG

CryptoRng Component Code

LOG

Log Component Code

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<sup>1)</sup> ... BU-ID document version number



## 11. Electromagnetic Compatibility

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Contactless reader RD 710 fulfil the following requirements of electromagnetic compatibility:

FCC, Part 15 and CE.

### 11.1 FCC Compliance Statement

**NOTE:**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

**Caution!**

The Federal Communications Commission warns the users that changes or modifications to the unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The accessories associated with this equipment are as follows:

- . Shielded communication cable

These accessories are required to be used in order to ensure compliance with FCC rules.

## 11.2 COMPLIANCE INFORMATION according to 47CFR 2.1077

NXP declares that the products

RD 710,  
FCC ID: OWRMFRD710

are in conformity with Part 15 of the FCC Rules.

Operation of this product is subject to the following conditions:

- (1) this device may not cause harmful interference
- (2) this device must accept any interference received, including interference that may cause undesired operation.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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#### RATP/Innovatron Technology

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