UFR Series NFC reader API reference

This document applies to Digital Logic's uFR Series readers only.

For more information, please visit http://www.d-logic.net/nfc-rfid-reader-sdk/

The scope of this document is to give a better insight and provide easy start with uFR Series NFC readers.

uFR Series readers communicate with the host via built in FTDI's USB to Serial interface chip.

If you have a uFR Series reader with RS232 interface, please refer to the "Communication protocol - uFR Series" document at our download section.

We provide dynamic libraries for all major OS: Win x86, Win X86_64, Linux x86, Linux x86_64, Linux ARM (and ARM HF with hardware float) and Mac OS X.

Our dynamic libraries rely on FTDI D2XX direct drivers. Most of them are already built in today's modern OS. However, we always suggest a clean driver installation procedure by downloading and installing drivers from FTDI's download webpage.

Android platform is supported through FTDI's Java D2XX driver. Since this approach introduces a new Java class, it shall be a scope of separate document.

Important update:

From library version 4.01 and up, it is possible to establish communication with reader without using FTDI's D2XX driver by calling the ReaderOpenEx function. Library can talk to the reader via COM port (physical or virtual) without implementing FTDI's calls. However, this approach is not as fast as with use of D2XX drivers but gives much more flexibility to users who had to use COM protocol only, now they can use the whole API set of functions via COM port.

Library naming convention

Dynamic libraries names are built upon following convention:

- Library always have "uFCoder" in its name as mandatory
- Prefix "lib" according to platform demands
- Suffix with architecture description
- Extension according to platform demands

Our standard library pack contains following libraries:

- libuFCoder-arm.so – for Linux on ARM platforms with software float
- libuFCoder-armhf.so - for Linux on ARM platforms with hardware float
- libuFCoder-x86.so – for Linux on Intel 32 bit platforms
- libuFCoder-x86_64.so - for Linux on Intel 64 bit platforms
- uFCoder-x86.dll – for Windows 32 bit
- uFCoder-x86_64.dll – for Windows 64 bit
- libuFCoder.dylib – for all OS X Intel based versions

Update policy: we release updated firmware and libraries frequently, with minor & major updates, bug-fixes, new features etc. All libraries mentioned above are affected with each update. Updates are absolutely free and can be obtained from our download page at “Libraries” section, while firmware updates are available at “Firmware” section by using software tool specially designed for that purpose. Library update package always have the following directory structure:

- “include” - contains “uFCoder.h” header file
- “linux” – contains directories “arm”, “armhf”, “x86” with appropriate libraries
- “osx” – contains library for OSX
- “windows” – contains libraries for Windows

and appropriate README file with short description of current revision.

Some considerations regarding platform specifics

Because FTDI driver is mandatory, proper installation method must be followed. See appendix for FTDI troubleshooting for details.

Reader’s firmware and library functions relation

When you call library function, in most cases you are issuing protocol command to reader firmware. Library functions are usually wrapped firmware commands. This approach is very convenient for rapid application development and as time saving feature. Particularly, library function does the following:

- Check if all function parameters are proper
- Send corresponding firmware command to reader with parameters given
- Parses reader’s response as “out” parameters and function result

There are exceptions of this rule for certain type of functions. For firmware functions, please refer to “Communication protocol - uFR Series” document at our download section.

Multi reader support

There can be many uFR Series readers connected to a single host. Natively, all library functions are intended for use with "single reader" configuration.

All "single reader" functions have corresponding "multi reader" function. Multi reader functions differs from the "single" functions by following:

Multi-function name always have suffix "M" at the end of function name

First parameter of Multi-function is always "Handle". For example,

```
SomeFunction(void) => SomeFunctionM(Handle)
OtherFunction(par1, par2) => OtherFunctionM(Handle, par1, par2)
```

More about Multi-function usage can be found in the Handling with multiple readers.

Function syntax and data types in this document

By default, all functions are shown as their prototypes in C language.

All data types refers C types, except new defined "c_string" data type which representing null terminated char array (also known as "C-String"). Array is always one byte longer (for null character) then string. "c_string" is defined as

`"typedef const char * c_string".`

For quick reference, always consult latest header file "uFCoder.h" at library package. Direct link to "uFCoder.h" can be found on the GIT repository: https://www.d-logic.net/code/nfc-rfid-reader-sdk/ufr-lib/blob/master/include/uFCoder.h

Error codes

All functions always have return result with corresponding status code. Please refer to table ERR_CODES in Appendix: ERROR CODES (DL_STATUS result).

In general you should always get function result = 0x00 if function is finished properly. One exception from this rule is if you get "0x08" – "NO_CARD" result. In a matter of fact, this is not an error, function is executed properly but there is no card present at readers RF field.

All other results indicates that some error occurred.

API set of functions

API set of functions is divided in three categories:

1. Common set
2. Advance set
3. Access control set

Common set of functions is shared among all uFR Series devices.

Advance set contains additional functions for use with uFR Advance and BASE HD uFR devices. It has additional functions for use of Real Time Clock (RTC) and user configurable EEPROM functions.

Access control set contains additional functions for use with BASE HD uFR devices. It has additional functions for use of I/O features like control of door lock, relay contacts and various inputs.

In further reading functions will be marked if they belong to Advance or Access control set.

Library functions

Functions are divided into several groups, based on purpose.

Reader and library related functions

Functions related to reader itself, to obtain some info or set certain device parameters.

Card/tag related commands

Functions used for card (or tag) data manipulation, such as obtaining some info, reading or writing data into card. Can be divided into several groups:

General purpose card related commands

Functions for getting common card data, not specific to card type.

Mifare Classic specific commands

Functions specific to Mifare Classic ® family of cards (Classic 1K and 4K). All functions are dedicated for use with Mifare Classic ® cards. However, some functions can be used with other card types, mostly in cases of direct addressing scheme and those functions will be highlighted in further text.

a) Block manipulation commands – direct and indirect addressing

   Functions for manipulating data in blocks of 16 byte according to Mifare Classic ® memory structure organization.

b) Value Block manipulation commands – direct and indirect addressing

   Functions for manipulating value blocks byte according to Mifare Classic ® memory structure organization.

c) Linear data manipulation commands

   Functions for manipulating data of Mifare Classic ® memory structure as a Linear data space.

From firmware version 5.0.29. same functions may be used with Mifare Plus ® card in SL3 mode. In SL3 mode uses the AES keys, which calculated from Crypto 1 keys.

NFC – NDEF related commands

Functions for reading and writing common NDEF messages and records into various NFC tags. Currently, only NFC Type 2 Tags are supported, while support for other NFC Tag types will be added in future upgrades.

NTAG related commands

Functions specific to NTAG ® family chips such as NTAG 203, 210, 212, 213, 215, 216. Due to the different memory sizes of various NTAG chips, we implemented functions for handling NTAG chips as generic NFC Type 2 Tag.

UID ASCII mirror support

NTAG 21x family offers a specific feature named "UID ASCII mirror function" which is supported by the uFR API using the function **`write_ndef_record_mirroring()`**. For details about "UID ASCII mirror function" refer to http://www.nxp.com/docs/en/data-sheet/NTAG213_215_216.pdf (in Rev. 3.2 from 2. June 2015, page 21) and http://www.nxp.com/docs/en/data-sheet/NTAG210_212.pdf (in Rev. 3.0 from 14. March 2013, page 16).

NFC counter mirror support

NTAG 213, 215 and 216 devices offer a specific feature named "NFC counter mirror function" which is supported by the uFR API using the function **`write_ndef_record_mirroring()`**. For details about "NFC counter mirror function" refer to a document http://www.nxp.com/docs/en/data-sheet/NTAG213_215_216.pdf (in Rev. 3.2 from 2. June 2015, page 23).

UID and NFC counter mirror support

NTAG 213, 215 and 216 devices offer a specific feature named "UID and NFC counter mirror function" which is supported by the uFR API using the function **`write_ndef_record_mirroring()`**. For details about "NFC counter mirror function" refer to a document http://www.nxp.com/docs/en/data-sheet/NTAG213_215_216.pdf (in Rev. 3.2 from 2. June 2015, page 26).

Mifare DESFire specific commands

Functions specific to Mifare DESFire® cards. All uFR Series readers support DESfire set of commands in AES encryption mode according to manufacturer's recommendations.

All readers have hardware built-in AES128 encryption mechanism. That feature provides fast and reliable results with DESFire cards without compromising security keys. Since DESFire EV1/EV2 cards come in DES mode as factory default setting (due to backward compatibility with older DESfire cards), cards must be turned to AES mode first. There is a library built in for that purpose.

From library version 5.0.14 and firmware version 5.0.25. operations with DES, 2K3DES, 3K3DES, and AES keys supported.

Authentication and password verification protection

Mifare Classic ® family of cards uses an authentication mechanism based on 6 bytes keys, which will be explained later in more detail.

NTAG ® 21x family chips and MIFARE Ultralight EV1 uses password verification protection based on PWD and PACK pairs which length is 6 bytes in total. PWD is 4 bytes in length and PACK is contained in 2 bytes. uFR API use this 6 bytes PWD/PACK pair (first goes 4 bytes of the PWD following by the 2 bytes of the PACK) to form PWD/PACK key which is used for password verification with those chip families in the similar manner as the authentication mechanism based on 6 bytes keys.

Selection of the authentication and password verification mechanisms, in the data manipulation functions, is based on the value of the **auth_mode** parameter.

For details about “Password verification protection” refer to following documents: http://www.nxp.com/docs/en/data-sheet/NTAG213_215_216.pdf (in Rev. 3.2 from 2. June 2015, page 30), http://www.nxp.com/docs/en/data-sheet/NTAG210_212.pdf (in Rev. 3.0 from 14. March 2013, page 19) and https://www.nxp.com/docs/en/data-sheet/MF0ULX1.pdf (in Rev. 3.2 from 23. Nov 2017, page 16).

Specific firmware features

There are few firmware features which are specific to uFR Series readers.

Tag Emulation mode

In this mode, the reader acts as a Tag. In that mode, not all library functions are available. Reader must be explicitly turned in or out of Tag Emulation mode. Maximum total size for emulated NDEF message is 144 bytes.

In further reading this topic will be covered in more detail.

Combined mode

In combined mode, the reader is switching from reader mode to Tag Emulation mode and vice versa a few times in seconds. Reader must be explicitly turned in or out of Combined mode.

In further reading this topic will be covered in more detail.

Asynchronous UID sending

This feature is turned off by default.

IF turned on, it will send card UID as a row of characters on COM port at defined speed using following format:

```
[Prefix byte] UID_chars [Suffix byte]
```

Where Prefix byte is optional and Suffix byte is mandatory.

In further reading this topic will be covered in more details.

Sleep and Auto Sleep feature

Sleep feature is turned off by default. If turned on, it will put reader into special low power consumption mode to preserve power. In this mode, reader will respond only on function to “wake up”: turn sleep off.

Autosleep feature is different than previous in one major point: it will put reader into sleep after a predefined amount of time and will respond to function calls. Time can be adjusted with dedicated API function.

In further reading this topic will be covered in more details.

Card UID remarks

uFR Series readers support Card Unique IDentifier (Card UID) with various byte length according to defined standards.

4 byte IDs: Non-unique IDs (NUID) are 4 byte long and as the name says, they are Non-Unique, so there is always possibility of existing two or more cards with the same ID (NUID).

7 byte IDs: Card UID are currently 7 byte long with never card types and still provide number range which large enough to provide uniqueness of IDs. These type of UIDs are fully supported at uFR series devices.

10 byte IDs: currently not in use but they are defined by standard for some future use. UFR Series devices are capable of handling this type of IDs when they become available.

Mifare Classic chips overview

One of the most popular and worldwide used contactless card type is NXP's Mifare Classic card, which comes in two memory map layouts: as 1K and 4K card.

Most of mentioned cards comes with 4 byte NUID. Cards with newer production date can be found with 7 byte UID too, especially MF1S70 type.

Mifare Classic 1K (MF1S50) and its derivatives has EEPROM with 1024 bytes storage, where 752 bytes are available for user data.

1 Kbyte EEPROM is organized in 16 sectors with 4 blocks each. A block contains 16 bytes. The last block of each sector is called “trailer”, which contains two secret keys (KeyA and KeyB) and programmable access conditions for each block in this sector.

Keys are encrypted with proprietary algorithm called “Crypto1”.

Figure 1 : MF1S50 memory map

Sector 0	Block 0	Manufacturer Data
	Block 1	DATA
	Block 2	DATA

	Block 3 Trailer	Keys and Access Conditions
Sector 1	Block 0	DATA
	Block 1	DATA
	Block 2	DATA
	Block 3 Trailer	Keys and Access Conditions
…		
Sector 15	Block 0	DATA
	Block 1	DATA
	Block 2	DATA
	Block 3 Trailer	Keys and Access Conditions

Mifare Classic 4K (MF1S70) and its derivatives has EEPROM with 4096 bytes storage, where 3440 bytes are available for user data.

4 Kbyte EEPROM is organized in 40 sectors with 4 blocks each. A block contains 16 bytes. The last block of each sector is called “trailer”, which contains two secret keys (KeyA and KeyB) and programmable access conditions for each block in this sector.

On the contrary of MF1S50, memory is organized in 32 sectors of 4 blocks (sectors 0 -31) and 8 sectors of 16 blocks (sectors 32 - 39).

Keys are encrypted with proprietary algorithm called “Crypto1”.

Figure 2 : MF1S70 memory map

Sector 0	Block 0	Manufacturer Data
	Block 1	DATA
	Block 2	DATA
	Block 3 Trailer	Keys and Access Conditions
Sector 1	Block 0	DATA
	Block 1	DATA
	Block 2	DATA
	Block 3 Trailer	Keys and Access Conditions
…		
Sector 31	Block 0	DATA
	Block 1	DATA
	Block 2	DATA
	Block 3 Trailer	Keys and Access Conditions
Sector 32	Block 0	DATA

	Block 1	DATA
	…	DATA
	Block 15 Trailer	Keys and Access Conditions
…		
Sector 39	Block 0	DATA
	Block 1	DATA
	…	DATA
	Block 15 Trailer	Keys and Access Conditions

Mifare Classic Keys and Access Conditions

Understanding memory map and access conditions of MF1S50 and MF1S70 cards is a must for proper data manipulation with mentioned cards.

Since that subject needs further reading and study, it is out of scope of this document.

Please refer to manufacturer’s technical documents for further details. Documents are available at public access on the manufacturer’s website.

Further reading of this document is not recommended before one get better insight and understanding of mentioned chip types.

We will try to give brief explanation of access bits and conditions. The next part of the text is taken from manufacturer’s documentation “MF1ICS50 – Functional specification” available publicly here.

Access conditions

The access conditions for every data block and sector trailer are defined by 3 bits, which are stored non-inverted and inverted in the sector trailer of the specified sector.

The access bits control the rights of memory access using the secret keys A and B. The access conditions may be altered, provided one knows the relevant key and the current access condition allows this operation.

Remark: With each memory access the internal logic verifies the format of the access conditions. If it detects a format violation the whole sector is irreversible blocked.

Remark: In the following description the access bits are mentioned in the non-inverted mode only.

The internal logic of the MF1ICS50 ensures that the commands are executed only after an authentication procedure or never.

Figure 1 Access conditions

Access Bits	Valid Commands	Block	Description

$C1_3$ $C2_3$ $C3_3$	read, write	3	sector trailer
$C1_2$ $C2_2$ $C3_2$	read, write, increment, decrement, transfer, restore	2	data block
$C1_1$ $C2_1$ $C3_1$	read, write, increment, decrement, transfer, restore	1	data block
$C1_0$ $C2_0$ $C3_0$	read, write, increment, decrement, transfer, restore	0	data block

Figure 2 Organization of Access Bits

Byte number	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Key A						Access bits				Key B					

Bits	7	6	5	4	3	2	1	0
Byte 6	$C2_3$	$C2_2$	$C2_1$	$C2_0$	$C1_3$	$C1_2$	$C1_1$	$C1_0$
Byte 7	$C1_3$	$C1_2$	$C1_1$	$C1_0$	$C3_3$	$C3_2$	$C3_1$	$C3_0$
Byte 8	$C3_3$	$C3_2$	$C3_1$	$C3_0$	$C2_3$	$C2_2$	$C2_1$	$C2_0$
Byte 9 (GPB)	General Purpose Byte - USER data							

Access conditions for the sector trailer

Depending on the access bits for the sector trailer (block 3) the read/write access to the keys and the access bits is specified as 'never', 'key A', 'key B' or key A|B' (key A or key B).

On chip delivery the access conditions for the sector trailers and key A are predefined as transport configuration. Since key B may be read in transport configuration, new cards must be authenticated with key A. Since the access bits themselves can also be blocked, special care should be taken during personalization of cards.

Figure 3 Access conditions for the sector trailer

Access value arg.	Access bits			Access condition for						Remark
				KEYA		Access bits		KEYB		
	$C1_3$	$C2_3$	$C3_3$	read	write	read	write	read	write	
0	0	0	0	never	key A	key A	never	key A	key A	Key B may be read[1]
2	0	1	0	never	never	key	never	key A	never	Key B may be read[1]

						A				
4	1	0	0	never	key B	key A|B	never	never	key B	
6	1	1	0	never	never	key A|B	never	never	never	
1	0	0	1	never	key A	key A	key A	key A	key A	Key B may be read, transport configuration[1]
3	0	1	1	never	key B	key A|B	key B	never	key B	
5	1	0	1	never	never	key A|B	key B	never	never	
7	1	1	1	never	never	key A|B	never	never	never	

[1] Remark: the grey marked lines are access conditions where key B is readable and may be used for data.

Access conditions for data blocks

Depending on the access bits for data blocks (blocks 0...2) the read/write access is specified as 'never', 'key A', 'key B' or 'key A|B' (key A or key B). The setting of the relevant access bits defines the application and the corresponding applicable commands.

●Read/write block: The operations read and write are allowed.

●Value block: Allows the additional value operations increment, decrement, transfer and restore. In one case ('001') only read and decrement are possible for a non-rechargeable card. In the other case ('110') recharging is possible by using key B.

●Manufacturer block: The read-only condition is not affected by the access bits setting!

Figure 4 Access conditions for data blocks

Access value (to the function)	Access bits			Access condition for				Application
	C1	C2	C3	read	write	increment	decrement, transfer, restore	
0	0	0	0	key A|B[1]	key A|B[1]	key A|B[1]	key A|B[1]	transport configuration
2	0	1	0	key A|B[1]	never	never	never	read/write block
4	1	0	0	key A|B[1]	key B[1]	never	never	read/write block
6	1	1	0	key A|B[1]	key B[1]	key B[1]	key A|B1	value block
1	0	0	1	key A|B[1]	never	never	key A|B[1]	value block
3	0	1	1	key B[1]	key B[1]	never	never	read/write block
5	1	0	1	key B[1]	never	never	never	read/write block
7	1	1	1	never	never	never	never	read/write block

●Key management: In transport configuration key A must be used for authentication[1]

Reader keys

All uFR Series devices has reserved nonvolatile memory space where following keys are stored:

- 32 Mifare Classic authentication keys, each 6 byte long, indexed [0-31]
- 16 AES keys for use with DESFire and Mifare Plus cards, each 16 bytes long, indexed [0-15]

All Mifare Classic keys have factory default value as 6 bytes of 0xFF.

All DESfire keys have factory default value as 16 bytes of 0x00.

Important Note: Keys are stored in reader using one way function and protected with password. Keys can be changed with appropriate credentials but can't be read in any circumstances. Please bear this in mind when handling key values.

Mifare Classic authentication modes and usage of keys

There are four possible ways of using Mifare keys when authenticating to card and they are named as follows:

- Reader Keys mode (RK) - default
- Automatic Key Mode 1 (AKM1)
- Automatic Key Mode 2 (AKM2)
- Provided Key mode (PK)

All Mifare Classic related functions have basic function name for default authentication method (RK) and three other variations with appended suffixes AKM1, AKM2 or PK. In further reading we will explain each basic function with variations of key mode usage.

All Mifare keys can be used as “Key A” or “Key B” as defined in Mifare Classic technical document.

For that purpose, each function which use authentication with keys also have parameter “AuthMode” which defines if particular key is used as “Key A” or “Key B”.

In uFR Series API there are two constants defined for this case :

`MIFARE_AUTHENT1A = 0x60` - actual key is used as “Key A”

[1] If Key B may be read in the corresponding Sector Trailer it can't serve for authentication (all grey marked lines in previous table). Consequences: If the RDW tries to authenticate any block of a sector with key B using grey marked access conditions, the card will refuse any subsequent access after authentication.

MIFARE_AUTHENT1B = 0x61 - actual key is used as “Key B”

For Mifare Plus cards in SL1 mode uses same authentication modes.

For Mifare Plus cards in SL3 mode uses these authentication modes, and

MIFARE_PLUS_AES_AUTHENT1A = 0x80

MIFARE_PLUS_AES_AUTHENT1B = 0x81

Reader Keys mode (RK)

When using this authentication mode, keys stored in reader's memory are used for authentication to Mifare card. Reader Key index [0..31] is passed as function argument.

Example:

Reader keys are all set to default value 6 bytes of 0xFF. We want to use key “A0 A1 A2 A3 A4 A5h” as key A to authenticate to card.

First this key must be stored into reader's NVRAM at certain index, for example index=3.

Next, we use “SomeFunction” to do something with card where authentication is must and key is “A0 A1 A2 A3 A4 A5h”. We will call “SomeFunction” with KeyIndex = 3 and AuthMode =” MIFARE_AUTHENT1A”.

In this way authentication key is not exposed during communication with host.

Mifare Plus card using.

From firmware versions 5.0.1. to 5.0.28, and library versions to 5.0.18, AES keys read from reader memory, and key index is 0 to 15.

From firmware versions 5.0.29, and library version from 5.0.19. for authentication modes MIFARE_AUTHENT1A and MIFARE_AUTHENT1B, AES keys calculated from Crypto1 keys read from Crypto1 key space (index 0 - 31), and for authentication modes MIFARE_PLUS_AES_AUTHENT1A and MIFARE_PLUS_AES_AUTHENT1B, AES keys read from AES keys space (index 0 - 15).

Automatic Key Mode 1 (AKM1)

This mode is also using keys stored at reader's memory. Difference between this mode and RK is that keys are used at predefined order.

In this mode, keys indexed from [0..15] are used as “Key A” for each corresponding sector while keys indexed from [16..31] are used as “Key B” for each corresponding sector. That means Key A for Sector 0 is Key indexed as [0] etc.

Brief example:

```
Sector 0  : Key A = Key [0], Key B = Key [16]
Sector 1  : Key A = Key [1], Key B = Key [17]
Sector 2  : Key A = Key [2], Key B = Key [18]
Sector 3  : Key A = Key [3], Key B = Key [19]
…
Sector 15 : Key A = Key [15], Key B = Key [31]
```

Mifare Plus card using.

For firmware versions from 5.0.1. to 5.0.28 in MIFARE_AUTHENT1A and MIFARE_AUTHENT1B mode, and from firmware version 5.0.29 and library version from 5.0.19 in MIFARE_PLUS_AES_AUTHENT1A and MIFARE_PLUS_AES_AUTHENT1B mode, uses AES keys from AES keys space (index 0 - 15). In this mode, keys indexed from [0..7] are used as “Key A” for each corresponding sector while keys indexed from [8..15] are used as “Key B” for each corresponding sector.

```
Sector 0  : Key A = Key [0], Key B = Key [8]
Sector 1  : Key A = Key [1], Key B = Key [9]
Sector 2  : Key A = Key [2], Key B = Key [10]
Sector 3  : Key A = Key [3], Key B = Key [11]
…
Sector 7  : Key A = Key [7], Key B = Key [15]
Sector 8  : Key A = Key [0], Key B = Key [8]
…
Sector 15 : Key A = Key [7], Key B = Key [15]
Sector 16 : Key A = Key [0], Key B = Key [8]
…
Sector 23 : Key A = Key [7], Key B = Key [15]
Sector 24 : Key A = Key [0], Key B = Key [8]
…
Sector 31 : Key A = Key [7], Key B = Key [15]
Sector 32 : Key A = Key [0], Key B = Key [8]
…
Sector 39 : Key A = Key [7], Key B = Key [15]
```

For firmware versions from 5.0.29 and library versions from 5.0.19 in MIFARE_AUTHENT1A and MIFARE_AUTHENT1B, uses AES keys calculated from Crypto1 keys from Crypto1 keys space (index - 31). Keys uses in same manner as for Mifare Classic card.

Automatic Key Mode 2 (AKM2)

This mode is also using keys stored at reader's memory. Difference is that keys are used at predefined order as even and odd keys.

In this mode, keys indexed with even numbers {0,2,4...30} are used as “Key A” for each corresponding sector while keys indexed with odd numbers {1,3,5...31} are used as “Key B” for each corresponding sector.

Brief example:

```
Sector 0  : Key A = Key [0], Key B = Key [1]
Sector 1  : Key A = Key [2], Key B = Key [3]
Sector 2  : Key A = Key [4], Key B = Key [5]
Sector 3  : Key A = Key [6], Key B = Key [7]
…
Sector 15 : Key A = Key [30], Key B = Key [31]
```

Mifare Plus card using.

For firmware versions from 5.0.1. to 5.0.28 in MIFARE_AUTHENT1A and MIFARE_AUTHENT1B mode, and from firmware version 5.0.29 and library version from 5.0.19 in MIFARE_PLUS_AES_AUTHENT1A and MIFARE_PLUS_AES_AUTHENT1B mode, uses AES keys from AES keys space (index 0 - 15). In this mode, keys indexed with even numbers {0,2,4...14} are used as “Key A” for each corresponding sector while keys indexed with odd numbers {1,3,5..15} are used as “Key B” for each corresponding sector.

```
Sector 0  : Key A = Key [0], Key B = Key [1]
Sector 1  : Key A = Key [2], Key B = Key [3]
Sector 2  : Key A = Key [4], Key B = Key [5]
Sector 3  : Key A = Key [6], Key B = Key [7]
…
Sector 7  : Key A = Key [14], Key B = Key [15]
Sector 8  : Key A = Key [0], Key B = Key [1]
…
Sector 15 : Key A = Key [14], Key B = Key [15]
Sector 16 : Key A = Key [0], Key B = Key [1]
…
Sector 23 : Key A = Key [14], Key B = Key [15]
Sector 24 : Key A = Key [0], Key B = Key [1]
```

```
…
Sector 31 : Key A = Key [14], Key B = Key [15]
Sector 32 : Key A = Key [0], Key B = Key [1]
…
Sector 39 : Key A = Key [14], Key B = Key [15]
```

For firmware versions from 5.0.29 and library versions from 5.0.19 in MIFARE_AUTHENT1A and MIFARE_AUTHENT1B, uses AES keys calculated from Crypto1 keys from Crypto1 keys space (index - 31). Keys uses in same manner as for Mifare Classic card.

NOTE: In all three above mentioned modes, when using Mifare Classic 4K cards, there are some trade off.

Mifare Classic 4K have 40 sectors instead of 16 as Mifare Classic 1K. In such case, Key A for Sector 0 is the same as Key A for Sector 16 etc. For the last 8 sectors (sectors 32 to 39) the same readers keys are used that correspond to sectors 0 to 7 and 16 to 23.

Example:

```
Sector 16 : Key A, Key B = Sector [0]  keys
Sector 17 : Key A, Key B = Sector [1]  keys
Sector 18 : Key A, Key B = Sector [2]  keys
Sector 31 : Key A, Key B = Sector [15] keys
…
Sector 32 : Key A, Key B = Sector [0]  keys
Sector 33 : Key A, Key B = Sector [1]  keys
…
Sector 39 : Key A, Key B = Sector [7]  keys
```

Provided Key mode (PK)

In this case keys stored into reader are not in use. Key is passed as function parameter as it's real value, like a pointer to array of bytes :“`A0 A1 A2 A3 A4 A5h`”.

For example, we will call “SomeFunction” with parameters “Key” and “AuthMode”, where “Key” is a pointer to byte array which contains key value bytes.

This method is convenient for testing but we strongly discourage use of this method in real production environments, since keys is exposed on “wire” during communication with host.

Mifare Plus card using.

For MIFARE_PLUS_AES_AUTHENT1A and MIFARE_PLUS_AES_AUTHENT1B mode, 16 bytes AES key provided to reader.

For firmware version from 5.0.29 in MIFARE_AUTHENT1A and MIFARE_AUTHENT1B, used AES key calculated from 6 bytes Crypto1 key which provided to reader.

Other supported cad/tag types

Currently supported card/tag types in latest firmware revision are:

- Mifare Classic (and derivatives like Fudan FM11RF08)
- Infineon SLE66R35
- Mifare Ultralight (directly supported NFC Type2 Tag)
- Mifare Ultralight C (directly supported NFC Type2 Tag)
- NTAG 203, 210, 212, 213, 215, 216 (directly supported NFC Type2 Tag)
- Mikron MIK640D (directly supported NFC Type2 Tag)
- Other NFC Type2 Tag compatible card are supported as ‘T2T generic type’, calling **`GetNfcT2tVersion()`** gives more data about tag.
- Mifare Plus (in Mifare Classic compatibility mode SL1 and SL3 from library version 4.3.13 and uFR PLUS devices)
- Mifare DESFire EV1 (AES key, and other keys DES, 2K3DES, 3K3DES from library version 5.0.14 and firmware version 5.0.25)
- Mifare DESFire EV2 (in EV1 compatibility mode)

Future firmware and library releases will support additional currently missing features and card types.

API - Programming reference

Scope of this section is to show basic usage scenarios of uFR Series API library functions.

For code snippets and source code examples, please refer to “SDK” section at our download web page.

Most examples are written in various programming languages including C/C++, C#.NET, C++.NET, VB.NET, Java, JavaScript, Python, Lazarus/Delphi.

Dynamic libraries are a part of source code example zip archives. Some libraries may be obsolete due to time of writing of example.

Please be sure to always use the latest library revision from “Libraries” section at our download web page.

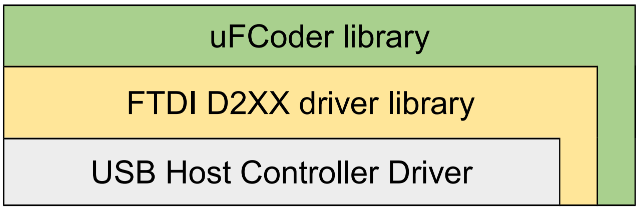
Simply replace obsolete libraries with latest library revision to explore all features mentioned in this document.

Communication and command flow

Communication with uFR Series reader (‘reader” in further text) is established via USB physical communication link.

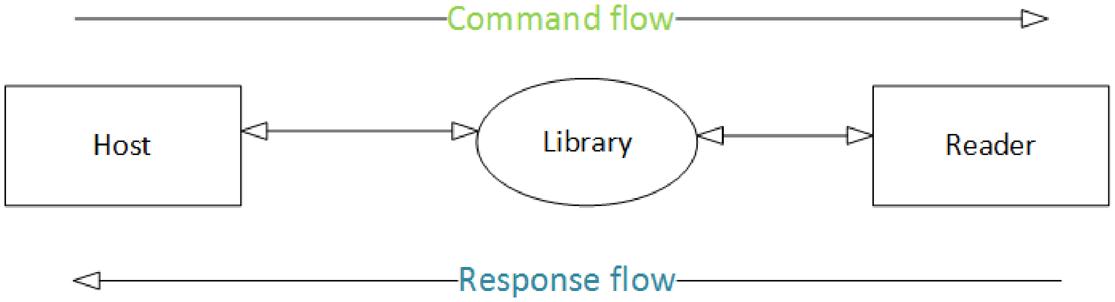
On top physical USB layer is FTDI’s direct access through D2XX drivers library.

uFR Series dynamic library (“uFCoder library” in further reading) is placed above D2XX library.



uFR Series device and host are in master-slave relation, where host represents master and device is a slave.

Command flow is always initiated from master to slave and device is only responding to commands.



The following sections will describe single reader usage, meaning that only one reader is connected to host.

Connecting several readers to single host is possible and shall be described in separate section.

Important update:

From library version 4.01 and up, it is possible to establish communication with reader without using FTDI’s D2XX driver by calling **ReaderOpenEx** function. Library can talk to reader via COM port (physical or virtual) without implementing FTDI’s calls. However, this approach is not fast as with use of D2XX drivers but gives much more flexibility to users who had to use COM protocol only, now they can use whole API set of functions via COM port.

uFCoder library
COM port (physical or virtual)

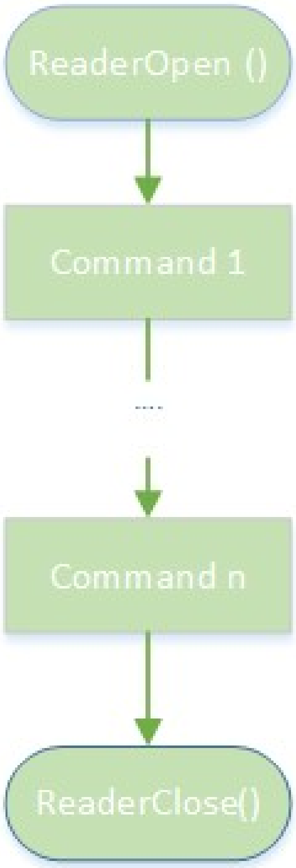
Program flow – basic usage

To establish communication with reader, there must be no other processes to disturbing this communication, which means that only one process or application can have open communication link with reader.

To establish communication link, ReaderOpen () command must be sent.

After successful link opening, all other library functions can be used.

At the end of use, link must be closed by ReaderClose () command, which is usually at application exit or process end.

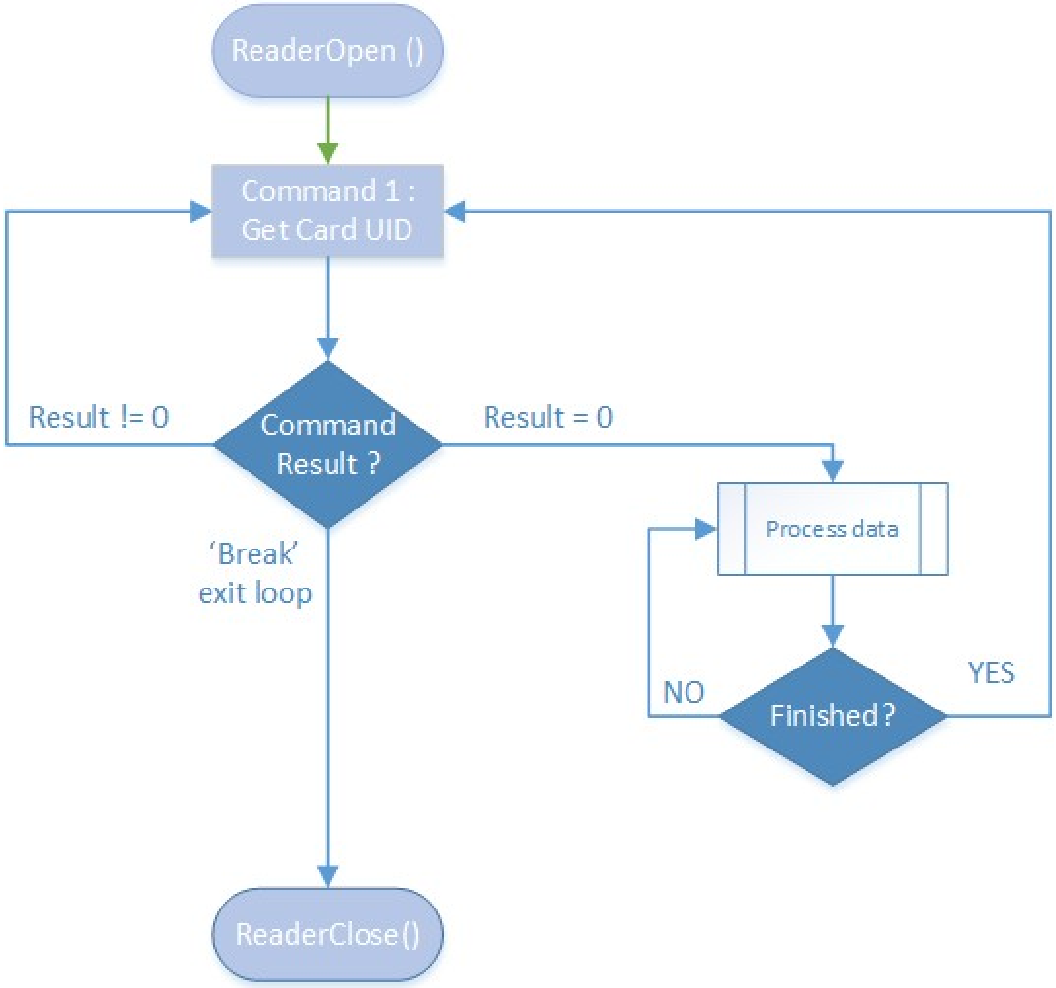


Program flow – polling

In many cases, there is a need to constantly examine some state or check for some events, like for card presence or similar. That is also known as “Polling Loop”.

In polling loop check is performed several times in second and number of check may vary. However, good practice is not to exceed 10 - 15 checks per second.

Almost all uFCoder library functions return Zero value if function call was successful and error code if not.



API - descriptions

Reader and library related functions

As mentioned earlier, uFCoder function call returns (in most cases) integer value as result of function operation. For possible values please refer to table ERR_CODES in Appendix: ERROR CODES (DL_STATUS result).

Exception from this rule are some functions with return parameters "c_string" which is a pointer to array of char ("*typedef const char * c_string*").

Here is a list of reader and library related functions with return types:

Reader and library functions	
Return Type	Function name
UFR_STATUS	ReaderOpen
UFR_STATUS	ReaderOpenEx
UFR_STATUS	ReaderOpen_uFROnline
UFR_STATUS	ReaderReset
UFR_STATUS	ReaderClose
UFR_STATUS	ReaderStillConnected
UFR_STATUS	GetReaderType
UFR_STATUS	GetReaderSerialNumber
UFR_STATUS	GetReaderHardwareVersion
UFR_STATUS	GetReaderFirmwareVersion
UFR_STATUS	GetBuildNumber
UFR_STATUS	GetReaderSerialDescription
UFR_STATUS	ChangeReaderPassword
UFR_STATUS	ReaderKeyWrite
UFR_STATUS	ReaderKeysLock
UFR_STATUS	ReaderKeysUnlock
UFR_STATUS	ReadUserData
UFR_STATUS	WriteUserData
UFR_STATUS	UfrEnterSleepMode
UFR_STATUS	UfrLeaveSleepMode
UFR_STATUS	AutoSleepSet
UFR_STATUS	AutoSleepGet
UFR_STATUS	SetSpeedPermanently
UFR_STATUS	GetSpeedParameters
UFR_STATUS	SetAsyncCardIdSendConfig
UFR_STATUS	GetAsyncCardIdSendConfig
UFR_STATUS	ReaderUISignal
UFR_STATUS	UfrRedLightControl
UFR_STATUS	SetDisplayData**
UFR_STATUS	SetDisplayIntensity**
UFR_STATUS	GetDisplayIntensity**
UFR_STATUS	SetSpeakerFrequency
uint32_t	GetDllVersion
c_string	GetDllVersionStr
c_string	UFR_STATUS2String
c_string	GetReaderDescription

** - RFU(reserved for future use)

ReaderOpen

Function description

Open reader communication port for all µFR devices. You can also use this function to open communication with µFR Online devices.

Using ReaderOpen to open communication with µFR Online devices:

If you have only one reader attached to your PC, it will open that reader serial port on 1Mbit/s, or if you have only one reader attached to another power supply (not your PC) it will open that reader based on it’s working mode (TCP or UDP). If you have more than one µFR Online device, ReaderOpen function will open the first one found, for opening another device, use ReaderOpenEx instead.

Function declaration (C language)

```
UFR_STATUS ReaderOpen(void)
```

No parameters required.

ReaderOpenByType

Function description

Opens a port of connected reader using readers family type. Useful for speed up opening for non uFR basic reader type (e.g. BaseHD with uFR support). Do not use this function for opening communication with µFR Online devices.

Function declaration (C language)

```
UFR_STATUS ReaderOpenByType(uint32_t reader_type);
```

Parameters

0 - auto, same as call ReaderOpen()

1 - uFR type (1 Mbps)

2 - uFR RS232 type (115200 bps)

3 - BASE HD uFR type (250 Kbps)

ReaderOpenEx

Function description
Open reader communication port in several different ways. Can be used for establishing communication with COM port too. There is enumeration in uFCoder.h file called E_READER_TYPE with values:

```
enum E_READER_TYPE

{

      AUTO = 0,

      UFR_TYPE = 1,

      UFR_RS232_TYPE = 2,

      BASEHD_UFR_TYPE = 3,

      UFR_ONLINE_TYPE = 4

};
```

Values in this enumeration you can pass into ReaderOpenEx function as `reader_type` parameter.
For example, if you pass 4 as `reader_type` it will only work with µFR Online Series devices, and then as `port_name` you can pass devices IP address or serial number (ex: “192.168.1.123” or “ON101390”), for `port_interface` you can pass ‘U’ for UDP, ‘T’ for TCP or 0. If you pass 0, it will automatically search for reader working mode (UDP or TCP) and open it. For argument you can pass 0 or µFR Nano device serial number to open it on 1Mbit/s (ex: “UN123456”).

Examples:

ReaderOpenEx(1, “COM1”, 0, 0)	This example will open communication with µFR device attached to COM1 port on 1Mbit/s
ReaderOpenEx(1, 0, 0, 0)	This example will automatically find COM port and open communication with first µFR device on 1Mbit/s
ReaderOpenEx(2, 0, 0, 0)	This example will automatically find COM port and open communication with first µFR RS232 device on 115200 bit/s
ReaderOpenEx(4, “ON123456”, ‘U’, 0)	This example will open communication with µFR Online reader with serial number ON123456 on UDP protocol.
ReaderOpenEx(4, “ON123456”, ‘T’, 0)	This example will open communication with

	µFR Online reader with serial number ON123456 on TCP protocol.
ReaderOpenEx(4, “192.168.1.123”, ‘U’, 0)	This example will open communication with µFR Online reader with IP address 192.168.1.123 on UDP protocol.
ReaderOpenEx(4, “192.168.1.123”, ‘T’, 0)	This will open communication with µFR Online reader with IP address 192.168.1.123 on TCP protocol.
ReaderOpenEx(4, “192.168.1.123”, 0, 0)	It will open communication with µFR Online reader with IP address 192.168.1.123 based on its working protocol (UDP or TCP), because we passed 0 as `port_interface`
ReaderOpenEx(4, “ON123456”, 0, 0)	It will open communication with µFR Online reader with serial number ON123456 based on its working protocol (UDP or TCP), because we passed 0 as `port_interface`
ReaderOpenEx(4, “ON123456”, 0, “UN654321”)	It will open communication with µFR Nano reader on 1Mbit/s with serial number UN654321 which is attached to µFR Online device with serial number ON123456
ReaderOpenEx(4, “192.168.1.123”, 0, “UN654321”)	It will open communication with µFR Nano reader on 1Mbit/s with serial number UN654321 which is attached to µFR Online device with IP address 192.168.1.123

Function declaration (C language)

```
UFR_STATUS ReaderOpenEx(uint32_t reader_type,
                        c_string port_name,
                        uint32_t port_interface,
                        void *arg);
```

Parameters

reader_type	0 : auto - same as call ReaderOpen() 1 : uFR type (1 Mbps) 2 : uFR RS232 type (115200 bps) 3 : BASE HD uFR type (250 Kbps) When uFR Online reader works in BT serial mode or transparent mode, reader_type must be set to 2.
port_name	is c-string type used to open port by given serial name. If you provide NULL or empty string that is AUTO MODE which calls ReaderOpenEx() and test all available ports on the system. serial port name, identifier, like "COM3" on Windows or "/dev/ttyS0" on Linux or "/dev/tty.serial1" on OS X or if you select FTDI, reader serial number like "UN123456", if reader have integrated FTDI interface When the UDP interface type is selected, port_name must be provided in “address:port” format. Like "192.168.1.162:8881" IP for UDP I/F
port_interface	type of communication interfaces (define interface which we use while connecting to the printer), supported value's: 0 : auto - first try FTDI than serial if port_name is not defined 1 : try serial / virtual COM port / interfaces 2 : try only FTDI communication interfaces 10 : try to open Digital Logic Shields with RS232 uFReader on Raspberry Pi (serial interfaces with GPIO reset) 84 ('T') : TCP/IP interface 85 ('U') : UDP interface 102 ('B'): BT serial interface. Android library only. 114 ('L'): BLE interface. Android library only. When uFR Online reader works in BT serial mode, port_interface must be set to 0 (Except Android).
arg	C-string with additional settings delimited with new lines. Settings C-string constant: “UNIT_OPEN_RESET_DISABLE” : do not reset the reader when opening “UNIT_OPEN_RESET_FORCE” : force reset the reader when opening "READER_ACTIVE_ON_RTS_LOW" : (default) Reset the reader when RTS is high - the reader works when RTS is low "READER_ACTIVE_ON_RTS_HIGH" : Reset the reader when RTS is low - the reader works when RTS is high

	"RTS_ALWAYS_HIGH" : not implemented yet "RTS_ALWAYS_LOW" : not implemented yet "RTS_DISCONNECTED" : disconnect RTS (RTS is not initiate nor use) When uFR Online reader works in BT serial mode or transparent mode, arg must be set to “UNIT_OPEN_RESET_DISABLE”. Custom baud rates from library version 5.0.28. For all RS232 devices and USB devices from firmware version 5.0.31 "BR_1000000" : 1 Mbps "BR_115200" : 115200 bps "BR_250000" : 250000 bps "BR_9600" : 9600 bps "BR_19200" : 19200 bps "BR_38400" : 38400 bps "BR_57600" : 57600 bps "BR_230400" : 234000 bps "BR_460800" : 460800 bps "BR_500000" : 500000 bps

ReaderOpen_uFROnline

Function description
Opens uFR Online device by serial number. Function will open communication (UDP or TCP) with device based on its working mode. If function cannot find given serial number, it will open communication on serial port with 1Mbit/s.

Function declaration (C language)

```
UFR_STATUS ReaderOpen_uFROnline(c_string serial_number)
```

Parameter

`serial_number`	Pointer to const char array (c_string) containing devices serial number (ex. “ON101390”).

ReaderReset

Function description

Physical reset of reader communication port.

Function declaration (C language)

```
UFR_STATUS ReaderReset(void)
```

No parameters required.

ReaderClose

Function description

Close reader communication port.

Function declaration (C language)

```
UFR_STATUS ReaderClose(void)
```

No parameters required.

ReaderStillConnected

Function description

Retrieve info if reader is still connected to host.

Function declaration (C language)

```
UFR_STATUS ReaderStillConnected(uint32_t *connected)
```

Parameter

connected	pointer to `connected` variable “`connected`” as result:	
	> 0	Reader is connected on system
	= 0	Reader is not connected on system anymore (or closed)
	< 0	other error
	“`connected`” - Pointer to unsigned int type variable 32 bit long, where the information about readers availability is written. If the reader is connected on system, function store 1 (true) otherwise, on some error, store zero in that variable.	

GetReaderType

Function description

Returns reader type as a pointer to 4 byte value.

Function declaration (C language)

```
UFR_STATUS GetReaderType(uint32_t *lpulReaderType)
```

Parameter

lpulReaderType	pointer to `lpulReaderType` variable. “`lpulReaderType`” as result – please refer to Appendix: DLogic reader type enumeration. E.g. for µFR Nano Classic readers this value is 0xD1180022.

GetReaderSerialNumber

Function description

Returns reader serial number as a pointer to 4 byte value.

Function declaration (C language)

```
UFR_STATUS GetReaderSerialNumber(uint32_t *lpulSerialNumber)
```

Parameter

lpulSerialNumber	pointer to `lpulSerialNumber` variable. “`lpulSerialNumber` “ as result holds 4 byte serial number value.

GetReaderHardwareVersion

Function description

Returns reader hardware version as two byte representation of higher and lower byte.

Function declaration (C language)

```
UFR_STATUS GetReaderHardwareVersion(uint8_t *version_major,
                                    uint8_t *version_minor);
```

Parameters

version_major	pointer to version major variable
version_minor	pointer to version minor variable

GetReaderFirmwareVersion

Function description

Returns reader firmware version as two byte representation of higher and lower byte.

Function declaration (C language)

```
UFR_STATUS GetReaderFirmwareVersion(uint8_t *version_major,
                                    uint8_t *version_minor);
```

Parameters

`version_major`	pointer to version major variable
`version_minor`	pointer to version minor variable

GetBuildNumber

Function description

Returns reader firmware build version as one byte representation.

Function declaration (C language)

```
UFR_STATUS GetBuildNumber(uint8_t *build)
```

Parameter

`build`	pointer to `build` variable

GetReaderSerialDescription

Function description

Returns reader’s descriptive name as a row of 8 chars.

Function declaration (C language)

```
UFR_STATUS GetReaderSerialDescription(uint8_t pSerialDescription[8])
```

Parameter

`pSerialDescription[8]`	pointer to pSerialDescription array

ChangeReaderPassword

Function description

This function is used in Common, Advance and Access Control set of functions.

It defines/changes password which I used for:

- Locking/unlocking keys stored into reader
- Setting date/time of RTC

Function declaration (C language)

```
UFR_STATUS ChangeReaderPassword(uint8_t *old_password,
                                uint8_t *new_password)
```

Parameters

old_password	pointer to the 8 bytes array containing current password
new_password	pointer to the 8 bytes array containing new password

ReaderKeyWrite

Function description

Store a new key or change existing key under provided index parameter.The keys are in a special area in EEPROM that can not be read anymore which gains protection.

Function declaration (C language)

```
UFR_STATUS ReaderKeyWrite(const uint8_t *aucKey,
                          uint8_t ucKeyIndex)
```

Parameters

aucKey	Pointer to an array of 6 bytes containing the key. Default key values are always “`FF FF FF FF FF FF`” hex.
ucKeyIndex	key Index. Possible values are 0 to 31.

ReaderKeysLock

Function description

Lock reader’s keys to prevent further changing.

Function declaration (C language)

```
UFR_STATUS ReaderKeysLock(const uint8_t *password);
```

Parameter

`password`	pointer to the 8 bytes array containing valid password.

ReaderKeysUnlock

Function description

Unlock reader's keys if they are locked with previous function.

The factory setting is that reader keys are unlocked.

Function declaration (C language)

```
UFR_STATUS ReaderKeysUnlock(const uint8_t *password);
```

Parameter

`password`	pointer to the 8 bytes array containing valid password.

ReaderSoftRestart

Function description

This function is used to restart the reader by software. It sets all readers parameters to default values and close RF field which resets all the cards in the field.

Function declaration (C language)

```
UFR_STATUS ReaderSoftRestart(void);
```

No parameters required.

ReadUserData

Function description

Read user data written in device NV memory.
User data is 16 byte long.

Function declaration (C language)

```
UFR_STATUS ReadUserData(uint8_t *aucData)
```

Parameter

`aucData`	pointer to 16 byte array containing user data.

WriteUserData

Function description

Write user data into device’s NV memory. User data is 16 byte long.

Function declaration (C language)

```
UFR_STATUS WriteUserData(uint8_t *aucData)
```

Parameter

`aucData`	pointer to 16 byte array containing user data.

UfrEnterSleepMode

Function description

Turn device into Sleep mode.

Function declaration (C language)

```
UFR_STATUS UfrEnterSleepMode(void)
```

No parameters used.

UfrLeaveSleepMode

Function description

Wake up device from Sleep mode.

Function declaration (C language)

```
UFR_STATUS UfrLeaveSleepMode(void)
```

No parameters used.

AutoSleepSet

Function description

Turn device into Sleep mode after certain amount of time.

Function declaration (C language)

```
UFR_STATUS AutoSleepSet(uint8_t seconds_wait)
```

Parameter

`seconds_wait`	variable holding value of seconds to wait before enter into sleep. If parameter is 0x00, AutoSleep feature is turned off (default state).

AutoSleepGet

Function description

Get status of AutoSleep mode.

Function declaration (C language)

```
UFR_STATUS AutoSleepGet(uint8_t seconds_wait)
```

Parameter

`seconds_wait`	variable holding value of seconds to wait before enter into sleep. If parameter is 0x00, AutoSleep feature is turned off (default state).

SetSpeedPermanently

Function description

This function is used for setting communication speed between reader and ISO144443-4 cards. For other card types, default speed of 106 kbps is in use.

Function declaration (C language)

```
UFR_STATUS SetSpeedPermanently (uint8_t tx_speed,
                                uint8_t rx_speed)
```

Parameters

`tx_speed`	setup value for transmit speed
`rx_speed`	setup value for receive speed

Valid speed setup values are:

Const	***Configured speed***
0	106 kbps (default)
1	212 kbps
2	424 kbps

On some reader types maximum **`rx_speed`** is 212 kbps. If you try to set higher speed than possible, reader will automatically set the maximum possible speed.

GetSpeedParameters

Function description

Returns baud rate configured with previous function.

Function declaration (C language)

```
UFR_STATUS  GetSpeedParameters(uint8_t *tx_speed,
                                          uint8_t *rx_speed)
```

Parameters

`tx_speed`	pointer to variable, returns configured value for transmit speed
`rx_speed`	pointer to variable, returns configured value for receive speed

SetAsyncCardIdSendConfig

Function description

This function is used for “Asynchronous UID sending” feature. Returned string contains hexadecimal notation of card ID with one mandatory suffix character and one optional prefix character.

Example:

Card ID is 0xA103C256, prefix is 0x58 ('X'), suffix is 0x59 ('Y')

Returned string is “XA103C256Y”

Function sets configuration parameters for this feature.

Function declaration (C language)

```
UFR_STATUS SetAsyncCardIdSendConfig (uint8_t send_enable,
                                     uint8_t prefix_enable,
                                     uint8_t prefix,
                                     uint8_t suffix,
                                     uint8_t send_removed_enable,
                                     uint32_t async_baud_rate);
```

Parameters

send_enable	turn feature on/off (0/1)
prefix_enable	use prefix or not (0/1)
prefix	prefix character
suffix	suffix character
send_removed_enable	Turn feature on/off (0/1). If feature is enabled then Asynchronous UID will also be sent when removing a card from the reader field.
async_baud_rate	baud rate value (e.g. 9600)

GetAsyncCardIdSendConfig

Function description

Returns info about parameters configured with previous function.

Function declaration (C language)

```
UFR_STATUS GetAsyncCardIdSendConfig (uint8_t *send_enable,
                                      uint8_t *prefix_enable,
                                      uint8_t *prefix,
                                      uint8_t *suffix,
                                      uint8_t *send_removed_enable,
                                      uint32_t *async_baud_rate);
```

Parameters

`send_enable`	pointer, if feature is on/off (0/1)
`prefix_enable`	pointer, if prefix is used or not (0/1)
`prefix`	pointer to variable holding prefix character
`suffix`	pointer to variable holding suffix character
`send_removed_enable`	Pointer. If value is 0 then feature is off. Otherwise, feature is on. If feature is enabled then Asynchronous UID is sent when the card is removed from the reader field.
`async_baud_rate`	pointer to variable holding configured baud rate

SetAsyncCardIdSendConfigEx

Function description

Function sets the parameters of card ID sending.

Function declaration (C language)

```
UFR_STATUS SetAsyncCardIdSendConfigEx(
     uint8_t send_enable,
     uint8_t prefix_enable,
     uint8_t prefix,
     uint8_t suffix,
     uint8_t send_removed_enable,
     uint8_t reverse_byte_order,
     uint8_t decimal_representation,
     uint32_t async_baud_rate);
```

Parameters

`send_enable`	turn feature on/off (0/1)
`prefix_enable`	use prefix or not (0/1)

prefix	prefix character
suffix	suffix character
send_removed_enable	Turn feature on/off (0/1). If feature is enabled then Asynchronous UID will also be sent when removing a card from the reader field.
reverse_byte_order	Turn feature on/off (0/1). If feature is disabled then the order of bytes (UID) will be as on card. If feature is enabled then the order of bytes will be reversed then the card's order of bytes.
decimal_representation	Turn feature on/off (0/1). If feature is enabled then the UID will be presented as a decimal number. If feature is disabled then the UID will be presented as a hexadecimal number
async_baud_rate	baud rate value (e.g. 9600)

GetAsyncCardIdSendConfigEx

Function description

Function returns the parameters of card ID sending.

Function declaration (C language)

```
UFR_STATUS                                      GetAsyncCardIdSendConfigEx(
     uint8_t                                                 *send_enable,
     uint8_t                                               *prefix_enable,
     uint8_t                                                      *prefix,
     uint8_t                                                      *suffix,
     uint8_t                                         *send_removed_enable,
     uint8_t                                          *reverse_byte_order,
     uint8_t                                      *decimal_representation,
     uint32_t *async_baud_rate);
```

Parameters

send_enable	pointer to the sending enable flag
prefix_enable	pointer to the prefix existing flag

`prefix`	pointer to prefix character
`suffix`	pointer to suffix character
`send_removed_enable`	pointer to flag
`reverse_byte_order`	pointer to flag
`decimal_representation`	pointer to flag
`async_baud_rate`	pointer to baud rate variable

ReaderUISignal

Function description

This function turns sound and light reader signals. Sound signals are performed by reader's buzzer and light signals are performed by reader's LEDs.

There are predefined signal values for sound and light:

`light_signal_mode`:		`beep_signal_mode`:	
0	None	0	None
1	Long Green	1	Short
2	Long Red	2	Long
3	Alternation	3	Double Short
4	Flash	4	Triple Short
		5	Triplet Melody

Function declaration (C language)

```
UFR_STATUS ReaderUISignal(uint8_t light_signal_mode,
                          uint8_t beep_signal_mode)
```

Parameters

`light_signal_mode`	value from table (0 - 4)
`beep_signal_mode`	value from table (0 - 5)

UfrRedLightControl

Function description

This function turns Red LED only.
If “light_status” value is 1, red light will be constantly turned on until receive “light_status “ value 0.

Function declaration (C language)

```
UFR_STATUS UfrRedLightControl(uint8_t light_status)
```

Parameter

`light_status`	value 0 or 1

SetSpeakerFrequency

Function description

This function plays constant sound of “`frequency`” Hertz.

Function declaration (C language)

```
UFR_STATUS SetSpeakerFrequency(uint16_t frequency)
```

Parameter

`frequency`	frequency in Hz

To stop playing sound, send 0 value for “`frequency`”.

SetUartSpeed

From version 5.0.28

Function description

This function sets communication speed (UART baud rate). Allowable values of baud rate are: 9600, 19200, 38400, 57600, 115200, 230400, 460800, 500000, and 1000000 bps. All RS232 devices are supported, and USB devices (Nano FR, Classic) from firmware version 5.0.31.

Function declaration (C language)

```
UFR_STATUS SetUartSpeed(uint32_t baud_rate);
```

Parameter

baud_rate	UART baud rate

SetDefaultUartSpeed

From version 5.0.28

Function description

This function returns communication speed (UART baud rate) to default value. For RS23 devices default communication speed is 115200 bps, and for USB devices is 1000000 bps.

For RS232 devices form version 5.0.1 (plus devices), and for USB devices from version 5.0.31.

Function declaration (C language)

```
UFR_STATUS SetDefaultUartSpeed(uint8_t reader_type,
                               uint8_t comm_type,
                               c_string port_name);
```

Parameters

reader_type	1 - USB 2 - RS232
comm_type	1 - COM port 2 - FTDI
port_name	If comm_type is FTDI enter empty string If comm_type is COM port Windows “COMx” Linux “/dev/ttyUSBx” Mac OS “/dev/tty.usbserial-xxxxxxxx”

Handling with multiple readers

If you want to communicate and use multiple readers from an application, you have to follow the initial procedure for enumerating uFR compatible devices and getting theirs handles. First call ReaderList_UpdateAndGetCount() to prepare internal list of connected devices and then call ReaderList_GetInformation() several times to get information of every reader.

Handle is used to identify certain reader when calling multi-functions (with suffix M).

ReaderList_UpdateAndGetCount

Function description

This is the first function in the order for execution for the multi-reader support.

The function prepare the list of connected uF-readers to the system and returns the number of list items - number of connected uFR devices.

ReaderList_UpdateAndGetCount() scan all communication ports for compatible devices, probes opened readers if still connected, if not close and mark their handles for deletion. If some device is disconnected from system this function should remove its handle.

Function declaration (C language)

```
UFR_STATUS ReaderList_UpdateAndGetCount(int32_t * NumberOfDevices);
```

Parameters

`NumberOfDevices`	how many compatible devices is connected to the system

Returns: status of execution

ReaderList_GetInformation

Function description

Function for getting all relevant information about connected readers.

You must call the function as many times as there are detected readers. E.g. If you have tree connected readers, detected by ReaderList_UpdateAndGetCount(), you should call this function tree times.

Function declaration (C language)

```
UFR_STATUS ReaderList_GetInformation(
          UFR_HANDLE *DeviceHandle,
          c_string *DeviceSerialNumber,
          int *DeviceType, int *DeviceFWver,
          int *DeviceCommID,int *DeviceCommSpeed,
          c_string *DeviceCommFTDISerial,
          c_string *DeviceCommFTDIDescription,
          int *DeviceIsOpened,
          int *DeviceStatus);
```

Parameters

DeviceHandle	assigned Handle to the uFR reader - pointer for general purpose (void * type in C)
DeviceSerialNumber	device serial number, pointer to static reserved information in library (no need to reserve memory space)
DeviceType	device identification in Digital Logic AIS database
DeviceFWver	version of firmware
DeviceCommID	device identification number (master)
DeviceCommSpeed	communication speed in bps
DeviceCommFTDISerial	FTDI COM port identification, pointer to static reserved information in library (no need to reserve memory space)
DeviceCommFTDIDescription	FTDI COM port description, pointer to static reserved information in library (no need to reserve memory space)
DeviceIsOpened	is Device opened - 0 not opened, other value is opened
DeviceStatus	actual device status

ReaderList_Destroy

Function description

Force handle deletion when you identify that the reader is no longer connected, and want to release the handle immediately. If the handle exists in the list of opened devices, function would try to close communication port and destroy the handle.

When uF-reader is disconnected ReaderList_UpdateAndGetCount() will do that (destroy) automatically in next execution.

Function declaration (C language)

```
UFR_STATUS ReaderList_Destroy(UFR_HANDLE DeviceHandle);
```

Parameter

`DeviceHandle`	the handle that will be destroyed

Example (in C):

```
int main(void)
{
     puts(GetDllVersionStr());

     UFR_STATUS status;
     int32_t NumberOfDevices;

     status = ReaderList_UpdateAndGetCount(&NumberOfDevices);
     if (status)
     {
          // TODO: check error
          printf("ReaderList_UpdateAndGetCount(): error= %s\n",
                 UFR_Status2String(status));

          return EXIT_SUCCESS;
     }

     printf("ReaderList_UpdateAndGetCount(): NumberOfDevices=
%d\n",
            NumberOfDevices);

     for (int i = 0; i < NumberOfDevices; ++i)
     {
          UFR_HANDLE DeviceHandle;
          c_string DeviceSerialNumber;
          int DeviceType;
          int DeviceFWver;
          int DeviceCommID;
          int DeviceCommSpeed;
          c_string DeviceCommFTDISerial;
          c_string DeviceCommFTDIDescription;
          int DeviceIsOpened;
          int DeviceStatus;

          status = ReaderList_GetInformation(&DeviceHandle,
                   &DeviceSerialNumber, &DeviceType, &DeviceFWver,
                   &DeviceCommID, &DeviceCommSpeed,
                   &DeviceCommFTDISerial,
&DeviceCommFTDIDescription,
                   &DeviceIsOpened, &DeviceStatus);

          printf("{%d/%d} DeviceHandle= %p, DeviceSerialNumber=
%s, "
             "DeviceType= %X, DeviceFWver= %d, "
             "DeviceCommID= %d, DeviceCommSpeed= %d, "
             "\n\t\t"
             "DeviceCommFTDISerial= %s, DeviceCommFTDIDescription=
%s, "
             "\n\t\t"
             "DeviceIsOpened= %d, DeviceStatus= %d\n", i + 1,
                        NumberOfDevices, DeviceHandle, DeviceSerialNumber,
                        DeviceType, DeviceFWver, DeviceCommID,
DeviceCommSpeed,
                        DeviceCommFTDISerial, DeviceCommFTDIDescription,
                        DeviceIsOpened, DeviceStatus);

                puts(GetReaderDescriptionM(DeviceHandle));
        }
        return EXIT_SUCCESS;
}
```

Helper library functions

GetDllVersionStr

Function description

This function returns library version as string.

Function declaration (C language)

```
c_string GetDllVersionStr(void)
```

No parameters used.

GetDllVersion

Function description

This function returns library version as number.

Function declaration (C language)

```
uint32_t GetDllVersion(void);
```

Returns compact version number, in little-endian format

Low Byte: Major version number

High Byte: Minor version number

Upper byte: Build number

Master Byte: reserved -

UFR_STATUS2String

Function description

This is helper library function. Returns DL_STATUS result code as readable descriptive data. Return type is string. For DL_STATUS enumeration, please refer to Appendix: ERROR CODES (DL_STATUS result).

Function declaration (C language)

```
c_string UFR_Status2String(const UFR_STATUS status)
```

GetReaderDescription

Function description

This function returns reader’s descriptive name. Return type is string. No parameters required.

Function declaration (C language)

```
c_string GetReaderDescription(void)
```

No parameters used.

Card/tag related commands

General purpose card related commands

Following functions are applicable to all card types.

UFR_STATUS	GetDlogicCardType
UFR_STATUS	GetCardId
UFR_STATUS	GetCardIdEx
UFR_STATUS	GetLastCardIdEx

GetDlogicCardType

Function description

This function returns card type according to DlogicCardType enumeration. For details, please refer to Appendix: DLogic CardType enumeration.

If the card type is not supported, function return the `lpucCardType` value equal to zero :
`TAG_UNKNOWN = 0x00`

Function declaration (C language)

```
UFR_STATUS GetDlogicCardType(uint8_t *lpucCardType)
```

Parameter

lpucCardType	pointer to `lpucCardType` variable. Variable `lpucCardType` holds returned value of actual card type present in RF field.

GetNfcT2TVersion

Function description

This function returns 8 bytes of the T2T version. All modern T2T chips support this functionality and have in common a total of 8 byte long version response. This function is primarily intended to use with NFC_T2T_GENERIC tags (i.e. tags which return 0x0C in the *lpucCardType parameter of the GetDlogicCardType()).

Function declaration (C language)

```
UFR_STATUS GetNfcT2TVersion(uint8_t lpucVersionResponse[8]);
```

Parameter

`lpucVersionResponse[8]`	array containing 8 bytes which will receive raw T2T version.

NfcT2TSafeConvertVersion

Function description

This is a helper function for converting raw array of 8 bytes received by calling **`GetNfcT2TVersion()`**. All modern T2T chips having same or very similar structure of the T2T version data represented in the uFR API by the structure type **`t2t_version_t`**:

```
typedef struct t2t_version_struct {
	uint8_t header;
	uint8_t vendor_id;
	uint8_t product_type;
	uint8_t product_subtype;
	uint8_t major_product_version;
	uint8_t minor_product_version;
	uint8_t storage_size;
	uint8_t protocol_type;
} t2t_version_t;
```

This function is primarily intended to use with NFC_T2T_GENERIC tags (i.e. tags which return 0x0C in the *lpucCardType parameter of the **`GetDlogicCardType()`**). Conversion done by this function is "alignment safe".

Function declaration (C language)

```
void NfcT2TSafeConvertVersion(t2t_version_t *version,
                              const uint8_t *version_record);
```

Parameters

`version`	pointer to the structure of the `t2t_version_t` type which will receive converted T2T version
`version_record`	pointer to array containing 8 bytes of the raw T2T version acquired using function `GetNfcT2TVersion()`

GetCardId

Function description

Returns card UID as a 4-byte array. This function is deprecated and used only for backward compatibility with older firmware versions (before v2.0). We strongly discourage use of this function. This function can't successfully handle 7 byte UIDS.

Function declaration (C language)

```
UFR_STATUS GetCardId(uint8_t *lpucCardType,
                     uint32_t *lpulCardSerial)
```

Parameters

`lpucCardType`	returns pointer to variable which holds card type according to SAK
`lpulCardSerial`	returns pointer to array of card UID bytes, 4 bytes long ONLY

GetCardIdEx

Function description

This function returns UID of card actually present in RF field of reader. It can handle all three known types : 4, 7 and 10 byte long UIDs.

This function is recommended for use instead of GetCardId.

Function declaration (C language)

```
UFR_STATUS GetCardIdEx(uint8_t *lpucSak,
                       uint8_t *aucUid,
                       uint8_t *lpucUidSize);
```

Parameters

`lpucSak`	returns pointer to variable which holds card type according to SAK
`aucUid`	returns pointer to array of card UID bytes, variable length

lpucUidSize	returns pointer to variable holding information about UID length

GetLastCardIdEx

Function description

This function returns UID of last card which was present in RF field of reader. It can handle all three known types : 4, 7 and 10 byte long UIDs. Difference with GetCardIdEx is that card does not be in RF field mandatory, UID value is stored in temporary memory area.

Function declaration (C language)

```
UFR_STATUS GetLastCardIdEx(uint8_t *lpucSak,
                           uint8_t *aucUid,
                           uint8_t *lpucUidSize);
```

Parameters :

lpucSak	returns pointer to variable which holds card type according to SAK
aucUid	returns pointer to array of card UID bytes, variable length
lpucUidSize	returns pointer to variable holding information about UID length

Mifare Classic specific functions

Functions specific to Mifare Classic ® family of cards (Classic 1K and 4K). All functions are dedicated for use with Mifare Classic ® cards. However, some functions can be used with other card types, mostly in cases of direct addressing scheme and those functions will be highlighted in further text. There are few types of following functions:

d) Block manipulation functions – direct and indirect addressing

   Functions for manipulating data in blocks of 16 byte according to Mifare Classic ® memory structure organization.

e) Value Block manipulation functions – direct and indirect addressing

   Functions for manipulating value blocks byte according to Mifare Classic ® memory structure organization.

f) Linear data manipulation functions

   Functions for manipulating data of Mifare Classic ® memory structure as a Linear data space.

Function's variations

All listed functions have 4 variations according to key mode, as explained earlier in chapter "Mifare Classic authentication modes and usage of keys". Let's take "BlockRead" function as example:

BlockRead	RK mode
BlockRead_AKM1	AKM1 mode
BlockRead_AKM2	AKM2 mode
BlockRead_PK	PK mode

Direct or Indirect addressing

In general, when speaking about direct and indirect addressing functions, both function types does the same thing. Main difference is in a way of block addressing.

Direct addressing functions use absolute value for Block address according to Mifare Classic memory map, where real block address (0-63) corresponds to function parameter value.

Indirect addressing functions use Block-In-Sector approach. Each Sector have 4 blocks (or more, for higher Sectors of the Mifare Classic 4K cards), so function always need two parameters: real Sector address and relative Block address in particular sector.

This approach is very useful for loop usage etc. Generally, it is up to user which one of these two function types will use.

Linear Address Data Space

Writing of consecutive data larger than 1 block (16 bytes) can be pretty tricky because of Mifare Classic memory organization map. Each 4th block is so called "Trailer Block" containing keys and access conditions.

For that purpose, uFR Series API use specific set of functions. User can write data even larger than 1 block without concerning about Trailer Blocks. Reader's firmware will take care of Trailer Blocks and arrange data in consecutive order, automatically jumping over Trailer Blocks. Parameters needed for this purpose are starting address in bytes and data length. Linear Address Data Space always begin at first free byte of specific card. In case of Mifare Classic cards, it is Byte 0 of Block 1 in Sector 0.

These type of functions can be used with other card types and Linear Address Data Space may start at different address. For example in case of Mifare Ultralight, Linear Address Data Space start at byte 0 of Page 4, exactly after OTP bytes page.

Following example shows how Linear Address Data Space looks like in case of Mifare Classic card.

Let's write "Data" of 85 bytes, indexed as 0..84 bytes.

Using LinearWrite function, we will send Data, Starting address 0 and DataLength 85.

Reader's firmware will do the rest in following manner:

Sector 0	Block 0	Manufacturer Block		
	Block 1	Bytes 0 -15	LINEAR SPACE	Linear Space starts here at Byte 0
	Block 2	Bytes 16 - 31		
	Block 3	Trailer		Jumping over Trailer
Sector 1	Block 0	Bytes 32 - 47		
	Block 1	Bytes 48 - 63		
	Block 2	Bytes 64 - 79		
	Block 3	Trailer		Jumping over Trailer
Sector 2	Block 0	Bytes 80- 84		Rest of Block is not changed (Bytes 5 - 15)

List of Mifare Classic specific functions

UFR_STATUS	BlockRead ***1**
UFR_STATUS	BlockWrite ***1**
UFR_STATUS	BlockInSectorRead
UFR_STATUS	BlockInSectorWrite
UFR_STATUS	LinearRead ***1**
UFR_STATUS	LinearWrite ***1**
UFR_STATUS	LinRowRead ***1**
UFR_STATUS	LinearFormatCard
UFR_STATUS	SectorTrailerWrite
UFR_STATUS	SectorTrailerWriteUnsafe
UFR_STATUS	ValueBlockRead
UFR_STATUS	ValueBlockWrite
UFR_STATUS	ValueBlockInSectorRead
UFR_STATUS	ValueBlockInSectorWrite
UFR_STATUS	ValueBlockIncrement
UFR_STATUS	ValueBlockDecrement
UFR_STATUS	ValueBlockInSectorIncrement
UFR_STATUS	ValueBlockInSectorDecrement

"***1**" – function can be used with NFC T2T card types (i.e. all varieties of the Mifare Ultralight, NTAG 203, NTAG 21x, Mikron MIK640D and other NFC_T2T_GENERIC tags).

If you want to use the following functions: ValueBlockRead(), ValueBlockWrite(), ValueBlockInSectorRead(), ValueBlockInSectorWrite(), ValueBlockIncrement(), ValueBlockDecrement(), ValueBlockInSectorIncrement() and ValueBlockInSectorDecrement(), then you need to change access bits for data blocks in chosen sector to one of the “value blocks application” access condition. You can do this using uFR API function SectorTrailerWrite().

BlockRead

Function description

Read particular block using absolute Block address.

Function declaration (C language)

```
UFR_STATUS BlockRead(uint8_t *data,
                     uint8_t block_address,
                     uint8_t auth_mode,
                     uint8_t key_index);

UFR_STATUS BlockRead_AKM1(uint8_t *data,
                          uint8_t block_address,
                          uint8_t auth_mode);

UFR_STATUS BlockRead_AKM2(uint8_t *data,
                          uint8_t block_address,
                          uint8_t auth_mode);

UFR_STATUS BlockRead_PK(uint8_t *data,
                        uint8_t block_address,
                        uint8_t auth_mode,
                        const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS BlockReadSamKey(uint8_t *data,
                     uint8_t block_address,
                     uint8_t auth_mode,
                     uint8_t key_index);
```

Parameters

data	Pointer to array of bytes containing data
block_address	Absolute block address
auth_mode	**For Mifare Classic** tags defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH** value 0x61 means "***use PWD_AUTH***" with BlockRead() or BlockRead_PK() functions. Value 0x60 with BlockRead() or BlockRead_PK() functions means "***without PWD_AUTH***" and in that case *you can send for ucReaderKeyIndex* or *aucProvidedKey parameters anything you want without influence on the result. For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you can use _AKM1 or _AKM2 function variants only* ***without PWD_AUTH*** *in any case of the valid values (0x60 or 0x61) provided for this parameter.* **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
key_index	Index of reader key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) (fw version to 5.0.28) For key into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.29 and library versions from 5.0.19. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)
key	Pointer to 6 bytes array containing Crypto1 key (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

When using this function with other card types, `auth_mode`, `key_index` and `key` parameters are not relevant but they must take default values.

BlockWrite

Function description

Write particular block using absolute Block address.

Function declaration (C language)

```
UFR_STATUS BlockWrite(uint8_t *data,
                      uint8_t block_address,
                      uint8_t auth_mode,
                      uint8_t key_index);

UFR_STATUS BlockWrite_AKM1(uint8_t *data,
                           uint8_t block_address,
                           uint8_t auth_mode);

UFR_STATUS BlockWrite_AKM2(uint8_t *data,
                           uint8_t block_address,
                           uint8_t auth_mode);

UFR_STATUS BlockWrite_PK(uint8_t *data,
                         uint8_t block_address,
                         uint8_t auth_mode, const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS BlockWriteSamKey(uint8_t *data,
                      uint8_t block_address,
                      uint8_t auth_mode,
                      uint8_t key_index);
```

Parameters

data	Pointer to array of bytes containing data
block_address	Absolute block address
auth_mode	**For Mifare Classic** tags defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH** value 0x61 means "***use PWD_AUTH***" with BlockWrite() or BlockWrite_PK() functions. Value 0x60 with BlockWrite() or BlockWrite_PK() functions means "***without PWD_AUTH***" and in that case *you can send for ucReaderKeyIndex* or *aucProvidedKey parameters anything you want without influence on the result. For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you can use _AKM1 or _AKM2 function variants only* ***without PWD_AUTH*** *in any case of the valid values (0x60 or 0x61) provided for this parameter.* **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
key_index	Index of reader key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) For key into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.29 and library versions from 5.0.19. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A

	or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)
key	Pointer to 6 bytes array containing Crypto1 key (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

When using this function with other card types, `auth_mode`, `key_index` and `key` parameters are not relevant but they must take default values.

BlockInSectorRead

Function description

Read particular block using relative Block in Sector address.

Function declaration (C language)

```
UFR_STATUS BlockInSectorRead(uint8_t *data, uint8_t sector_address,
                         uint8_t block_in_sector_address,
                         uint8_t auth_mode, uint8_t key_index);

UFR_STATUS BlockInSectorRead_AKM1(uint8_t *data, uint8_t
sector_address,
                         uint8_t block_in_sector_address,
                         uint8_t auth_mode);

UFR_STATUS BlockInSectorRead_AKM2(uint8_t *data, uint8_t
sector_address,
                         uint8_t block_in_sector_address,
                         uint8_t auth_mode);

UFR_STATUS BlockInSectorRead_PK(uint8_t *data,uint8_t sector_address,
                         uint8_t block_in_sector_address,
                         uint8_t auth_mode,
                         const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS BlockInSectorReadSamKey(uint8_t *data,
                         uint8_t sector_address,

                         uint8_t block_in_sector_address,
                         uint8_t auth_mode, uint8_t key_index);
```

Parameters

data	Pointer to array of bytes containing data
sector_address	Absolute Sector address
block_in_sector_address	Block address in Sector
auth_mode	**For Mifare Classic** tags defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61

	For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH value 0x61 means “***use PWD_AUTH***“ with BlockInSectorRead() or BlockInSectorRead_PK() functions. Value 0x60 with BlockInSectorRead() or BlockInSectorRead_PK() functions means “***without PWD_AUTH***“ and in that case *you can send for ucReaderKeyIndex or aucProvidedKey parameters anything you want without influence on the result. For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you can use _AKM1 or _AKM2 function variants only* ***without PWD_AUTH*** *in any case of the valid values (0x60 or 0x61) provided for this parameter.* **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
`key_index`	Index of reader key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) For keys into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.29 and library versions from 5.0.19. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)
`key`	Pointer to 6 bytes array containing Crypto1 key (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

BlockInSectorWrite

Function description

Write particular block using relative Block in Sector address.

Function declaration (C language)

```
UFR_STATUS BlockInSectorWrite(uint8_t *data, uint8_t sector_address,
                         uint8_t block_in_sector_address,
                         uint8_t auth_mode, uint8_t key_index);

UFR_STATUS BlockInSectorWrite_AKM1(uint8_t *data,
                         uint8_t sector_address,
                         uint8_t block_in_sector_address,
                         uint8_t auth_mode);

UFR_STATUS BlockInSectorWrite_AKM2(uint8_t *data,
                         uint8_t sector_address,
                         uint8_t block_in_sector_address,
                         uint8_t auth_mode);

UFR_STATUS BlockInSectorWrite_PK(uint8_t *data, uint8_t sector_address,
                         uint8_t block_in_sector_address,
                         uint8_t auth_mode, const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS BlockInSectorWriteSamKey(uint8_t *data,
                         uint8_t sector_address,

                         uint8_t block_in_sector_address,
                         uint8_t auth_mode, uint8_t key_index);
```

Parameters

`data`	Pointer to array of bytes containing data
`sector_address`	Absolute Sector address
`block_in_sector_address`	Block address in Sector
`auth_mode`	**For Mifare Classic** tags defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH** value 0x61 means "***use PWD_AUTH***" with BlockInSectorWrite() or BlockInSectorWrite_PK() functions. Value 0x60 with BlockInSectorWrite() or BlockInSectorWrite_PK() functions means "***without PWD_AUTH***" and in that case *you can send for ucReaderKeyIndex* or *aucProvidedKey parameters anything you want without influence on the result. For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you can use _AKM1 or _AKM2 function variants only* ***without PWD_AUTH*** *in any case of the valid values (0x60 or 0x61) provided for this parameter.* **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80

	or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
`key_index`	Index of reader key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) For keys into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.29 and library versions from 5.0.19. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)
`key`	Pointer to 6 bytes array containing Crypto1 key (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

LinearRead

Function description

Group of functions for linear reading in uFR firmware utilise FAST_READ ISO 14443-3 command with NTAG21x and Mifare Ultralight EV1 tags.

Function declaration (C language)

```
UFR_STATUS LinearRead(uint8_t *Data, uint16_t linear_address,
               uint16_t length, uint16_t *bytes_returned,
               uint8_t auth_mode, uint8_t key_index);

UFR_STATUS LinearRead_AKM1(uint8_t *Data, uint16_t linear_address,
               uint16_t length, uint16_t *bytes_returned, uint8_t
          auth_mode);

UFR_STATUS LinearRead_AKM2(uint8_t *Data, uint16_t linear_address,
               uint16_t length, uint16_t *bytes_returned, uint8_t
          auth_mode);

UFR_STATUS LinearRead_PK(uint8_t *Data, uint16_t linear_address,
               uint16_t length, uint16_t *bytes_returned,
               uint8_t auth_mode, const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS LinearReadSamKey(uint8_t *Data, uint16_t linear_address,

               uint16_t length, uint16_t *bytes_returned,
               uint8_t auth_mode, uint8_t key_index);
```

Parameters

`data`	Pointer to array of bytes containing data
`linear_address`	Address of byte – where to start reading

length	Length of data – how many bytes to read
bytes_returned	Pointer to variable holding how many bytes are returned
auth_mode	**For Mifare Classic** tags defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH** value 0x61 means "***use PWD_AUTH***" with LinearRead() or LinearRead_PK() functions. Value 0x60 with LinearRead() or LinearRead_PK() functions means "***without PWD_AUTH***" and in that case *you can send for ucReaderKeyIndex* or *aucProvidedKey parameters anything you want without influence on the result. For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you can use _AKM1 or _AKM2 function variants only **without PWD_AUTH** in any case of the valid values (0x60 or 0x61) provided for this parameter.* **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
key_index	Index of reader key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) For keys into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.29 and library versions from 5.0.19. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)
key	Pointer to 6 bytes array containing Crypto1 key (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

When using this functions with other card types, `auth_mode`, `key_index` and `key` parameters are not relevant but must take default values.

LinearWrite

Function description

These functions are used for writing data to the card using emulation of the linear address space. The method for proving authenticity is determined by the suffix in the functions names.

Function declaration (C language)

```
UFR_STATUS LinearWrite(uint8_t *Data,
                       uint16_t linear_address,
                       uint16_t length,
                       uint16_t *bytes_returned,
                       uint8_t auth_mode,
                       uint8_t key_index);

UFR_STATUS LinearWrite_AKM1(uint8_t *Data,
                            uint16_t linear_address,
                            uint16_t length,
                            uint16_t *bytes_returned,
                            uint8_t auth_mode);

UFR_STATUS LinearWrite_AKM2(uint8_t *Data,
                            uint16_t linear_address,
                            uint16_t length,
                            uint16_t *bytes_returned,
                            uint8_t auth_mode);

UFR_STATUS LinearWrite_PK(uint8_t *Data,
                          uint16_t linear_address,
                          uint16_t length,
                          uint16_t *bytes_returned,
                          uint8_t auth_mode,
                          const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS LinearWriteSamKey(uint8_t *Data,
                       uint16_t linear_address,
                       uint16_t length,
                       uint16_t *bytes_returned,
                       uint8_t auth_mode,
                       uint8_t key_index);
```

Parameters

`data`	Pointer to array of bytes containing data
`linear_address`	Address of byte – where to start writing
`length`	Length of data – how many bytes to write
`bytes_returned`	Pointer to variable holding how many bytes are returned
`auth_mode`	**For Mifare Classic** tags defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH** value 0x61 means "***use PWD_AUTH***" with LinearWrite() or LinearWrite_PK() functions. Value 0x60 with LinearWrite() or LinearWrite_PK() functions means "***without PWD_AUTH***" and in that case *you can send for ucReaderKeyIndex* or *aucProvidedKey parameters anything you want without influence on the result. For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you can use _AKM1 or _AKM2 function variants only* ***without PWD_AUTH*** *in any case of the valid*

	values (0x60 or 0x61) provided for this parameter. **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
key_index	Index of reader key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) For keys into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.29 and library versions from 5.0.19. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)
key	Pointer to 6 bytes array containing Crypto1 key (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

When using this function with other card types, `auth_mode`, `key_index` and `key` parameters are not relevant but must take default values.

LinRowRead

Function description

Read Linear data Address Space. On the contrary of LinearRead functions, this functions read whole card including trailer blocks and manufacturer block.

This function is useful when making “dump” of the whole card.

Group of functions for linear reading in uFR firmware utilise FAST_READ ISO 14443-3 command with NTAG21x and Mifare Ultralight EV1 tags.

Function declaration (C language)

```
UFR_STATUS LinRowRead(uint8_t *Data,
                      uint16_t linRow_address,
                      uint16_t length,
                      uint16_t *bytes_returned,
                      uint8_t auth_mode,
                      uint8_t key_index);

UFR_STATUS LinRowRead_AKM1(uint8_t *Data,
                           uint16_t linRow_address,
                           uint16_t length,
                           uint16_t *bytes_returned,
                           uint8_t auth_mode);

UFR_STATUS LinRowRead_AKM2(uint8_t *Data,
                           uint16_t linRow_address,
                           uint16_t length,
                           uint16_t *bytes_returned,
                           uint8_t auth_mode);

UFR_STATUS LinRowRead_PK(uint8_t *Data,
                         uint16_t linRow_address,
                         uint16_t length,
                         uint16_t *bytes_returned,
                         uint8_t auth_mode,
                         const uint8_t *key);
```

Parameters

data	Pointer to array of bytes containing data
linear_address	Address of byte – where to start reading
length	Length of data – how many bytes to read
bytes_returned	Pointer to variable holding how many bytes are returned
auth_mode	**For Mifare Classic** tags defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH** value 0x61 means “***use PWD_AUTH***“ with LinRowRead() or LinRowRead_PK() functions. Value 0x60 with LinRowRead() or LinRowRead_PK() functions means “***without PWD_AUTH***“ and in that case *you can send for ucReaderKeyIndex* or *aucProvidedKey parameters anything you want without influence on the result. For NTAG 21x, Ultralight EV1 and other T2T tags supporting PWD_AUTH you can use _AKM1 or _AKM2 function variants only* ***without PWD_AUTH*** *in any case of the valid values (0x60 or 0x61) provided for this parameter.*
key_index	Index of reader’s key to be used (RK mode)
key	Pointer to 6 byte array containing key bytes (PK mode)

When using this function with other card types, `auth_mode`, `key_index` and `key` parameters are not relevant but they must take default values.

LinearFormatCard

Function description

This function is specific to Mifare Classic cards only. It performs “Format card” operation - write new Sector Trailer values on whole card at once. It writes following data:

KeyA, Block Access Bits, Trailer Access Bits, GeneralPurposeByte(GPB), KeyB, same as construction of Sector Trailer.

Bytes 0 – 5	Bytes 6 - 8	Byte 9	Bytes 10 - 15
KeyA	Block Access & Trailer Access Bits	GPB	KeyB

For more information, please refer to Mifare Classic Keys and Access Conditions in this document.

Mifare Plus using.

For firmware versions from 5.0.29 and library versions from 5.0.19, this functions may be used for Mifare plus cards. If authetntication mode is MIFARE_AUTHENT1A or MIFARE_AUTHENT1B, AES key for authentication, and new AES key A and new AES key B are caluculate from Crypto1 keys. If authentication mode is MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B, new AES keys are provode to reader.

Function declaration (C language)

```
UFR_STATUS LinearFormatCard(const uint8_t *new_key_A,
                            uint8_t blocks_access_bits,
                            uint8_t sector_trailers_access_bits,
                            uint8_t sector_trailers_byte9,
                            const uint8_t *new_key_B,
                            uint8_t *lpucSectorsFormatted,
                            uint8_t auth_mode,
                            uint8_t key_index);

UFR_STATUS LinearFormatCard_AKM1(const uint8_t *new_key_A,
                                 uint8_t blocks_access_bits,
                                 uint8_t sector_trailers_access_bits,
                                 uint8_t sector_trailers_byte9,
                                 const uint8_t *new_key_B,
                                 uint8_t *lpucSectorsFormatted,
                                 uint8_t auth_mode);

UFR_STATUS LinearFormatCard_AKM2(const uint8_t *new_key_A,
                                 uint8_t blocks_access_bits,
                                 uint8_t sector_trailers_access_bits,
                                 uint8_t sector_trailers_byte9,
                                 const uint8_t *new_key_B,
                                 uint8_t *lpucSectorsFormatted,
                                 uint8_t auth_mode);

UFR_STATUS LinearFormatCard_PK(const uint8_t *new_key_A,
                               uint8_t blocks_access_bits,
                               uint8_t sector_trailers_access_bits,
                               uint8_t sector_trailers_byte9,
                               const uint8_t *new_key_B,
                               uint8_t *lpucSectorsFormatted,
                               uint8_t auth_mode,
                               const uint8_t *key);
```

These functions are used for new keys A and B writing as well as access bits in the trailers of all card sectors. Ninth bit setting is enabled. The same value is set for the entire card. If you need to prove authenticity on the base of previous keys, these functions are suitable to initialize the new card or re-initialize the card with the same keys and access rights for all sectors.

Parameters

`new_key_A`	Pointer on 6 bytes array containing a new KeyA
`blocks_access_bits`	Block Access permissions bits. Values 0 to 7
`sector_trailers_access_bits`	Sector Trailer Access permissions bits. Values 0 to 7
`sector_trailers_byte9`	GPB value
`new_key_B`	Pointer on 6 bytes array containing a new KeyA
`lpucSectorsFormatted`	Pointer to variable holding return value how many sectors are successfully formatted
`auth_mode`	Defines whether to perform authentication with key A or

	key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61
key_index	Index of reader's key to be used (RK mode)
key	Pointer to 6 byte array containing key bytes (PK mode)

This function can't be used with other card types except Mifare Classic.

GetCardSize

Function description

Function returns size of user data space on the card (LinearSize), and size of total data space on the card (RawSize). The user data space is accessed via functions LinearWrite and LinearRead. Total data space is accessed via functions LinRowWrite and LinRowRead. For example Mifare Classic 1K card have 752 bytes of user data space (sector trailers and block 0 are not included), and 1024 bytes of total data space.

Function declaration (C language)

```
UFR_STATUS GetCardSize(uint32_t *lpulLinearSize,
                       uint32_t *lpulRawSize);
```

Parameters

lpulLinearSize	pointer to variable which contain size of user data space
lpulRawSize	pointer to variable which contain size of total data space

SectorTrailerWrite

Function description

This function is specific to Mifare Classic cards only. It writes new Sector Trailer value at one Sector Trailer. It writes following data:

KeyA, Block Access Bits, Trailer Access Bits, GeneralPurposeByte(GPB), KeyB, same as construction of Sector Trailer.

Mifare Plus using.

For firmware versions from 5.0.29 and library versions from 5.0.19, this functions may be used for Mifare plus cards. If authentication mode is MIFARE_AUTHENT1A or MIFARE_AUTHENT1B, AES key for authentication, and new AES key A and new AES key B are calculated from Crypto1 keys. If authentication mode is MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B, new AES keys are provided to reader.

Function declaration (C language)

```
UFR_STATUS SectorTrailerWrite(uint8_t addressing_mode,
                              uint8_t address,
                              const uint8_t *new_key_A,
                              uint8_t block0_access_bits,
                              uint8_t block1_access_bits,
                              uint8_t block2_access_bits,
                              uint8_t sector_trailers_access_bits,
                              uint8_t sector_trailers_byte9,
                              const uint8_t *new_key_B,
                              uint8_t auth_mode,
                              uint8_t key_index);

UFR_STATUS SectorTrailerWrite_AKM1(uint8_t addressing_mode,
                                   uint8_t address,
                                   const uint8_t *new_key_A,
                                   uint8_t block0_access_bits,
                                   uint8_t block1_access_bits,
                                   uint8_t block2_access_bits,
                                   uint8_t sector_trailers_access_bits,
                                   uint8_t sector_trailers_byte9,
                                   const uint8_t *new_key_B,
                                   uint8_t auth_mode);

UFR_STATUS SectorTrailerWrite_AKM2(uint8_t addressing_mode,
                                   uint8_t address,
                                   const uint8_t *new_key_A,
                                   uint8_t block0_access_bits,
                                   uint8_t block1_access_bits,
                                   uint8_t block2_access_bits,
                                   uint8_t sector_trailers_access_bits,
                                   uint8_t sector_trailers_byte9,
                                   const uint8_t *new_key_B,
                                   uint8_t auth_mode);

UFR_STATUS SectorTrailerWrite_PK(uint8_t addressing_mode,
                                 uint8_t address,
                                 const uint8_t *new_key_A,
                                 uint8_t block0_access_bits,
                                 uint8_t block1_access_bits,
                                 uint8_t block2_access_bits,
                                 uint8_t sector_trailers_access_bits,
                                 uint8_t sector_trailers_byte9,
                                 const uint8_t *new_key_B,
                                 uint8_t auth_mode,
                                 const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS SectorTrailerWriteSamKey(uint8_t addressing_mode,
                              uint8_t address,
                              const uint8_t *new_key_A,
                              uint8_t block0_access_bits,
                              uint8_t block1_access_bits,
                              uint8_t block2_access_bits,
                              uint8_t sector_trailers_access_bits,
                              uint8_t sector_trailers_byte9,
                              const uint8_t *new_key_B,
                              uint8_t auth_mode,
                              uint8_t key_index);
```

Parameters

addressing_mode	Defines if Absolute (0) or Relative (1) Block Addressing mode is used
address	Address of Trailer according to addressing_mode
new_key_A	Pointer on 6 bytes array containing a new KeyA
block0_access_bits	Access Permissions Bits for Block 0. Values 0 to 7
block1_access_bits	Access Permissions Bits for Block 1. Values 0 to 7
block2_access_bits	Access Permissions Bits for Block 2. Values 0 to 7
sector_trailers_access_bits	Sector Trailer Access permissions bits. Values 0 to 7
sector_trailers_byte9	GPB value
new_key_B	Pointer on 6 bytes array containing a new KeyB
auth_mode	Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61
key_index	Index of reader's key to be used (RK mode)
key	Pointer to 6 byte array containing key bytes (PK mode)

This function can't be used with other card types except Mifare Classic.

For “Block Access Bits” please refer to Mifare Classic Keys and Access Conditions in this document.

For Mifare Classic 4K (MF1S70), in higher addresses range (Sectors 31 - 39), where one sector has 16 blocks, `block0_access_bits` corresponds to blocks 0-4, `block1_access_bits` corresponds to blocks 5-9 and `block2_access_bits` corresponds to blocks 10-15.

SectorTrailerWriteUnsafe

Function description

This function is specific to Mifare Classic cards only. It writes new Sector Trailer value at one Sector Trailer. It writes following data:

KeyA, Block Access Bits, Trailer Access Bits, GeneralPurposeByte(GPB), KeyB, same as construction of Sector Trailer.

Difference between this function and SectorTrailerWrite is :

- SectorTrailerWrite will check parameters and “safely” write them into trailer, non valid values will not be written
- SectorTrailerWriteUnsafe writes array of 16 bytes as raw binary trailer representation, any value can be written.

USE THIS FUNCTION WITH CAUTION, WRONG VALUES CAN DESTROY CARD!

Function declaration (C language)

```
UFR_STATUS SectorTrailerWriteUnsafe(uint8_t addressing_mode,
                                    uint8_t address,
                                    uint8_t *sector_trailer,
                                    uint8_t auth_mode,
                                    uint8_t key_index);

UFR_STATUS SectorTrailerWriteUnsafe_AKM1(uint8_t addressing_mode,
                                         uint8_t address,
                                         uint8_t *sector_trailer,
                                         uint8_t auth_mode);

UFR_STATUS SectorTrailerWriteUnsafe_AKM2(uint8_t addressing_mode,
                                         uint8_t address,
                                         uint8_t *sector_trailer,
                                         uint8_t auth_mode);

UFR_STATUS SectorTrailerWriteUnsafe_PK(uint8_t addressing_mode,
                                       uint8_t address,
                                       uint8_t *sector_trailer,
                                       uint8_t auth_mode,
                                       const uint8_t *key);
```

Parameters

addressing_mode	Defines if Absolute (0) or Relative (1) Block Addressing mode is used
address	Address of Trailer according to addressing_mode
sector_trailers	Pointer to 16 byte array as binary representation of Sector Trailer
auth_mode	Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61
key_index	Index of reader’s key to be used (RK mode)
key	Pointer to 6 byte array containing key bytes (PK mode)

This function can’t be used with other card types except Mifare Classic.

ValueBlockRead

Function description

Read particular Value block using absolute Block address. This function uses Mifare Classic specific mechanism of reading value which is stored into whole block. Value blocks have a fixed data format which permits error detection and correction and a backup management. Value is a signed 4-byte value and it is stored three times, twice non-inverted and once inverted. Negative numbers are stored in standard 2's complement format. For more info, please refer to Mifare Classic documentation.

Mifare Plus X, SE and EV1 using.

For firmware versions from 5.0.36 and library versions from 5.0.34, this functions may be used for Mifare plus cards. If authentication mode is MIFARE_AUTHENT1A or MIFARE_AUTHENT1B, AES key for authentication, and new AES key A and new AES key B are calculate from Crypto1 keys. If authentication mode is MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B, new AES keys are provided to reader.

Function declaration (C language)

```
UFR_STATUS ValueBlockRead(int32_t *value,
                          uint8_t *value_addr,
                          uint8_t block_address,
                          uint8_t auth_mode,
                          uint8_t key_index);

UFR_STATUS ValueBlockRead_AKM1(int32_t *value,
                               uint8_t *value_addr,
                               uint8_t block_address,
                               uint8_t auth_mode);

UFR_STATUS ValueBlockRead_AKM2(int32_t *value,
                               uint8_t *value_addr,
                               uint8_t block_address,
                               uint8_t auth_mode);

UFR_STATUS ValueBlockRead_PK(int32_t *value,
                             uint8_t *value_addr,
                             uint8_t block_address,
                             uint8_t auth_mode,
                             const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS ValueBlockReadSamKey(int32_t *value,
                          uint8_t *value_addr,
                          uint8_t block_address,
                          uint8_t auth_mode,
                          uint8_t key_index);
```

Parameters

`value`	Pointer to variable where retrieved value will be stored
`Value_addr`	Signifies a 1-byte address, which can be used to save the storage address of a block, when implementing a powerful backup management. For more info, please refer to Mifare Classic documentation.
`block_address`	Absolute block address

auth_mode	Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
key_index	Index of reader's key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) (fw version to 5.0.36) For key into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.36 and library versions from 5.0.34. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)
key	Pointer to 6 byte array containing key bytes (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

ValueBlockWrite

Function description

Write particular Value block using absolute Block address. This function uses Mifare Classic specific mechanism of writing value which is stored into whole block. Value blocks have a fixed data format which permits error detection and correction and a backup management. Value is a signed 4-byte value and it is stored three times, twice non-inverted and once inverted. Negative numbers are stored in standard 2's complement format. For more info, please refer to Mifare Classic documentation.

Mifare Plus X, SE and EV1 using.

For firmware versions from 5.0.36 and library versions from 5.0.34, this functions may be used for Mifare plus cards. If authentication mode is MIFARE_AUTHENT1A or MIFARE_AUTHENT1B, AES key for authentication, and new AES key A and new AES key B are calculate from Crypto1 keys. If authentication mode is MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B, new AES keys are provided to reader.

Function declaration (C language)

```
UFR_STATUS ValueBlockWrite(int32_t *value,
                           uint8_t *value_addr,
                           uint8_t block_address,
                           uint8_t auth_mode,
                           uint8_t key_index);
UFR_STATUS ValueBlockWrite_AKM1(int32_t *value,
                                uint8_t *value_addr,
                                uint8_t block_address,
                                uint8_t auth_mode);
UFR_STATUS ValueBlockWrite_AKM2(int32_t *value,
                                uint8_t *value_addr,
                                uint8_t block_address,
                                uint8_t auth_mode);
UFR_STATUS ValueBlockWrite_PK(int32_t *value,
                              uint8_t *value_addr,
                              uint8_t block_address,
                              uint8_t auth_mode,
                              const uint8_t *key);
```

```
*only uFR CS with SAM support
```

```
UFR_STATUS ValueBlockWriteSamKey(int32_t *value,
                           uint8_t *value_addr,
                           uint8_t block_address,
                           uint8_t auth_mode,
                           uint8_t key_index);
```

Parameters

`value`	Pointer to value to be stored
`Value_addr`	Signifies a 1-byte address, which can be used to save the storage address of a block, when implementing a powerful backup management. For more info, please refer to Mifare Classic documentation.
`block_address`	Absolute block address
`auth_mode`	Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
`key_index`	Index of reader's key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) (fw version to 5.0.36) For key into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.36 and library versions from 5.0.34. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B

	mode uses AES keys (0 - 15)
key	Pointer to 6 byte array containing key bytes (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

ValueBlockInSectorRead

Function description

Read particular Value block using absolute Block address. This function uses Mifare Classic specific mechanism of reading value which is stored into whole block. Value blocks have a fixed data format which permits error detection and correction and a backup management. Value is a signed 4-byte value and it is stored three times, twice non-inverted and once inverted. Negative numbers are stored in standard 2's complement format. For more info, please refer to Mifare Classic documentation.

Mifare Plus X, SE and EV1 using.

For firmware versions from 5.0.36 and library versions from 5.0.34, this functions may be used for Mifare plus cards. If authentication mode is MIFARE_AUTHENT1A or MIFARE_AUTHENT1B, AES key for authentication, and new AES key A and new AES key B are calculate from Crypto1 keys. If authentication mode is MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B, new AES keys are provided to reader.

Function declaration (C language)

```
UFR_STATUS ValueBlockInSectorRead(int32_t *value,
                                  uint8_t *value_addr,
                                  uint8_t sector_address,
                                  uint8_t block_in_sector_address,
                                  uint8_t auth_mode,
                                  uint8_t key_index);

UFR_STATUS ValueBlockInSectorRead_AKM1(int32_t *value,
                                  uint8_t *value_addr,
                                  uint8_t sector_address,
                                  uint8_t block_in_sector_address,
                                  uint8_t auth_mode);

UFR_STATUS ValueBlockInSectorRead_AKM2(int32_t *value,
                                  uint8_t *value_addr,
                                  uint8_t sector_address,
                                  uint8_t block_in_sector_address,
                                  uint8_t auth_mode);

UFR_STATUS ValueBlockInSectorRead_PK(int32_t *value,
                                  uint8_t *value_addr,
                                  uint8_t sector_address,
                                  uint8_t block_in_sector_address,
                                  uint8_t auth_mode,
                                  const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS ValueBlockInSectorReadSamKey(int32_t *value,

                                  uint8_t *value_addr,
                                  uint8_t sector_address,
                                  uint8_t block_in_sector_address,
                                  uint8_t auth_mode,
                                  uint8_t key_index);
```

Parameters

`value`	Pointer to variable where retrieved value will be stored
`Value_addr`	Signifies a 1-byte address, which can be used to save the storage address of a block, when implementing a powerful backup management. For more info, please refer to Mifare Classic documentation.
`sector_address`	Absolute Sector address
`block_in_sector_address`	Block address in Sector

auth_mode	Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
key_index	Index of reader's key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) (fw version to 5.0.36) For key into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.36 and library versions from 5.0.34. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)
key	Pointer to 6 byte array containing key bytes (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

ValueBlockInSectorWrite

Function description

Write particular Value block using absolute Block address. This function uses Mifare Classic specific mechanism of writing value which is stored into whole block. Value blocks have a fixed data format which permits error detection and correction and a backup management. Value is a signed 4-byte value and it is stored three times, twice non-inverted and once inverted. Negative numbers are stored in standard 2's complement format. For more info, please refer to Mifare Classic documentation.

Mifare Plus X, SE and EV1 using.

For firmware versions from 5.0.36 and library versions from 5.0.34, this functions may be used for Mifare plus cards. If authentication mode is MIFARE_AUTHENT1A or MIFARE_AUTHENT1B, AES key for authentication, and new AES key A and new AES key B are calculate from Crypto1 keys. If authentication mode is MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B, new AES keys are provided to reader.

Function declaration (C language)

```
UFR_STATUS ValueBlockInSectorWrite(int32_t value,
                                   uint8_t value_addr,
                                   uint8_t sector_address,
                                   uint8_t block_in_sector_address,
                                   uint8_t auth_mode,
                                   uint8_t key_index);

UFR_STATUS ValueBlockInSectorWrite_AKM1(int32_t value,
                                   uint8_t value_addr,
                                   uint8_t sector_address,
                                   uint8_t block_in_sector_address,
                                   uint8_t auth_mode);

UFR_STATUS ValueBlockInSectorWrite_AKM2(int32_t value,
                                   uint8_t value_addr,
                                   uint8_t sector_address,
                                   uint8_t block_in_sector_address,
                                   uint8_t auth_mode);

UFR_STATUS ValueBlockInSectorWrite_PK(int32_t value,
                                   uint8_t value_addr,
                                   uint8_t sector_address,
                                   uint8_t block_in_sector_address,
                                   uint8_t auth_mode,
                                   const uint8_t *key);
```

```
*only uFR CS with SAM support
```

```
UFR_STATUS ValueBlockInSectorWriteSamKey(int32_t value,
                                   uint8_t value_addr,
                                   uint8_t sector_address,
                                   uint8_t block_in_sector_address,
                                   uint8_t auth_mode,
                                   uint8_t key_index);
```

Parameters

`value`	Pointer to value to be stored
`Value_addr`	Signifies a 1-byte address, which can be used to save the storage address of a block, when implementing a powerful backup management. For more info, please refer to Mifare Classic documentation.
`sector_address`	Absolute Sector address
`block_in_sector_address`	Block address in Sector

auth_mode	Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
key_index	Index of reader's key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) (fw version to 5.0.36) For key into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.36 and library versions from 5.0.34. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)
key	Pointer to 6 byte array containing key bytes (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

ValueBlockIncrement

Function description

Increments particular Value block with specified value using absolute Block address.

Mifare Plus X, SE and EV1 using.

For firmware versions from 5.0.36 and library versions from 5.0.34, this functions may be used for Mifare plus cards. If authentication mode is MIFARE_AUTHENT1A or MIFARE_AUTHENT1B, AES key for authentication, and new AES key A and new AES key B are calculate from Crypto1 keys. If authentication mode is MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B, new AES keys are provided to reader.

Function declaration (C language)

```
UFR_STATUS ValueBlockIncrement(int32_t increment_value,
                               uint8_t block_address,
                               uint8_t auth_mode,
                               uint8_t key_index);

UFR_STATUS ValueBlockIncrement_AKM1(int32_t increment_value,
                                    uint8_t block_address,
                                    uint8_t auth_mode;

UFR_STATUS ValueBlockIncrement_AKM2(int32_t increment_value,
                                    uint8_t block_address,
                                    uint8_t auth_mode);

UFR_STATUS ValueBlockIncrement_PK(int32_t increment_value,
                                  uint8_t block_address,
                                  uint8_t auth_mode,
                                  const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS ValueBlockIncrementSamKey(int32_t increment_value,
                               uint8_t block_address,
                               uint8_t auth_mode,
                               uint8_t key_index);
```

Parameters

increment_value	value showing how much initial block value will be incremented
block_address	Absolute block address
auth_mode	Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
key_index	Index of reader's key to be used (RK mode) For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) (fw version to 5.0.36) For key into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.36 and library versions from 5.0.34. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)
key	Pointer to 6 byte array containing key bytes (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

ValueBlockDecrement

Function description

Decrements particular Value block with specified value using absolute Block address.

Mifare Plus X, SE and EV1 using.

For firmware versions from 5.0.36 and library versions from 5.0.34, this functions may be used for Mifare plus cards. If authentication mode is MIFARE_AUTHENT1A or MIFARE_AUTHENT1B, AES key for authentication, and new AES key A and new AES key B are calculate from Crypto1 keys. If authentication mode is MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B, new AES keys are provided to reader.

Function declaration (C language)

```
UFR_STATUS ValueBlockDecrement(int32_t decrement_value,
                               uint8_t block_address,
                               uint8_t auth_mode,
                               uint8_t key_index);

UFR_STATUS ValueBlockDecrement_AKM1(int32_t decrement_value,
                                    uint8_t block_address,
                                    uint8_t auth_mode;

UFR_STATUS ValueBlockDecrement_AKM2(int32_t decrement_value,
                                    uint8_t block_address,
                                    uint8_t auth_mode);

UFR_STATUS ValueBlockDecrement_PK(int32_t decrement_value,
                                  uint8_t block_address,
                                  uint8_t auth_mode,
                                  const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS ValueBlockDecrementSamKey(int32_t decrement_value,
                               uint8_t block_address,
                               uint8_t auth_mode,
                               uint8_t key_index);
```

Parameters

`increment_value`	value showing how much initial block value will be decremented
`block_address`	Absolute block address
`auth_mode`	Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
`key_index`	Index of reader's key to be used (RK mode)

	For Crypto1 keys (0 - 31) For Mifare Plus AES keys (0 -15) (fw version to 5.0.36) For key into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.36 and library versions from 5.0.34. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)
key	Pointer to 6 byte array containing key bytes (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

ValueBlockInSectorIncrement

Function description

Increments particular Value block with specified value using Block in Sector address.

Mifare Plus X, SE and EV1 using.

For firmware versions from 5.0.36 and library versions from 5.0.34, this functions may be used for Mifare plus cards. If authentication mode is MIFARE_AUTHENT1A or MIFARE_AUTHENT1B, AES key for authentication, and new AES key A and new AES key B are calculate from Crypto1 keys. If authentication mode is MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B, new AES keys are provided to reader.

Function declaration (C language)

```
UFR_STATUS
ValueBlockInSectorIncrement(int32_t increment_value,
                            uint8_t sector_address,
                            uint8_t block_in_sector_address,
                            uint8_t auth_mode,
                            uint8_t key_index);

UFR_STATUS
ValueBlockInSectorIncrement_AKM1(int32_t increment_value,
                                 uint8_t sector_address,
                                 uint8_t block_in_sector_address,
                                 uint8_t auth_mode);

UFR_STATUS
ValueBlockInSectorIncrement_AKM2(int32_t increment_value,
                                 uint8_t sector_address,
                                 uint8_t block_in_sector_address,
                                 uint8_t auth_mode);

UFR_STATUS
ValueBlockInSectorIncrement_PK(int32_t increment_value,
                               uint8_t sector_address,
                               uint8_t block_in_sector_address,
                               uint8_t auth_mode,
                               const uint8_t *key);
```

```
*only uFR CS with SAM support
```

```
UFR_STATUS
ValueBlockInSectorIncrementSamKey(int32_t increment_value,
                            uint8_t sector_address,
                            uint8_t block_in_sector_address,
                            uint8_t auth_mode,
                            uint8_t key_index);
```

Parameters

`increment_value`	value showing how much initial block value will be incremented
`sector_address`	Absolute Sector address
`block_in_sector_address`	Block address in Sector
`auth_mode`	Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
`key_index`	Index of reader's key to be used (RK mode) For Crypto1 keys (0 - 31)

	For Mifare Plus AES keys (0 -15) (fw version to 5.0.36) For key into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.36 and library versions from 5.0.34. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)
key	Pointer to 6 byte array containing key bytes (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

ValueBlockInSectorDecrement

Function description

Decrements particular Value block with specified value using Block in Sector address.

Mifare Plus X, SE and EV1 using.

For firmware versions from 5.0.36 and library versions from 5.0.34, this functions may be used for Mifare plus cards. If authentication mode is MIFARE_AUTHENT1A or MIFARE_AUTHENT1B, AES key for authentication, and new AES key A and new AES key B are calculate from Crypto1 keys. If authentication mode is MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B, new AES keys are provided to reader.

Function declaration (C language)

```
UFR_STATUS
ValueBlockInSectorDecrement(int32_t decrement_value,
                            uint8_t sector_address,
                            uint8_t block_in_sector_address,
                            uint8_t auth_mode,
                            uint8_t key_index);

UFR_STATUS
ValueBlockInSectorDecrement_AKM1(int32_t decrement_value,
                                 uint8_t sector_address,
                                 uint8_t block_in_sector_address,
                                 uint8_t auth_mode);

UFR_STATUS
ValueBlockInSectorDecrement_AKM2(int32_t decrement_value,
                                 uint8_t sector_address,
                                 uint8_t block_in_sector_address,
                                 uint8_t auth_mode);

UFR_STATUS
ValueBlockInSectorDecrement_PK(int32_t decrement_value,
                               uint8_t sector_address,
                               uint8_t block_in_sector_address,
                               uint8_t auth_mode,
                               const uint8_t *key);

*only uFR CS with SAM support
UFR_STATUS
ValueBlockInSectorDecrementSamKey(int32_t decrement_value,
                            uint8_t sector_address,
                            uint8_t block_in_sector_address,
                            uint8_t auth_mode,
                            uint8_t key_index);
```

Parameters

decrement_value	value showing how much initial block value will be decremented
sector_address	Absolute Sector address
block_in_sector_address	Block address in Sector
auth_mode	Defines whether to perform authentication with key A or key B: use KeyA - MIFARE_AUTHENT1A = 0x60 or KeyB - MIFARE_AUTHENT1B = 0x61 **For Mifare Plus** tags (PK mode) defines whether to perform authentication with key A or key B: use KeyA - MIFARE_PLUS_AES_AUTHENT1A = 0x80 or KeyB - MIFARE_PLUS_AES_AUTHENT1B = 0x81
key_index	Index of reader's key to be used (RK mode) For Crypto1 keys (0 - 31)

	For Mifare Plus AES keys (0 -15) (fw version to 5.0.36) For key into SAM (1 - 127) For Mifare Plus and fw versions from 5.0.36 and library versions from 5.0.34. in MIFARE_AUTHENT1A or MIFARE_AUTHENT1B mode uses AES key calculated from Crypto1 key (0 -31), and in MIFARE_PLUS_AES_AUTHENT1A or MIFARE_PLUS_AES_AUTHENT1B mode uses AES keys (0 - 15)
key	Pointer to 6 byte array containing key bytes (PK mode) For Mifare Plus pointer to 16 bytes array containing AES key (PK mode)

Additional general functions for working with the cards

Functions that support NDEF records

get_ndef_record_count

Function description

Function returns the number of NDEF messages that have been read from the card, and number of NDEF records, number of NDEF empty messages. Also, function returns array of bytes containing number of messages pairs. First byte of pair is message ordinal, and second byte is number of NDEF records in that message. Message ordinal starts from 1.

Function declaration (C language)

```
UFR_STATUS get_ndef_record_count(
               uint8_t *ndef_message_cnt,
               uint8_t *ndef_record_cnt,
               uint8_t *ndef_record_array,
               uint8_t *empty_ndef_message_cnt);
```

Parameters

ndef_message_cnt	pointer to the variable containing number of NDEF messages
ndef_record_cnt	pointer to the variable containing number of NDEF record
ndef_record_array	pointer to the array of bytes containing pairs (message ordinal – number of records)
empty_ndef_message_cnt	pointer to the variable containing number of

	empty messages

read_ndef_record

Function description

Function returns TNF, type of record, ID and payload from the NDEF record. NDEF record shall be elected by the message ordinal and record ordinal in this message.

Function declaration (C language)

```
UFR_STATUS read_ndef_record(uint8_t message_nr,
               uint8_t record_nr,
               uint8_t *tnf,
               uint8_t *type_record,
               uint8_t *type_length,
               uint8_t *id,
               uint8_t *id_length,
               uint8_t *payload,
               uint32_t *payload_length);
```

Parameters

`message_nr`	NDEF message ordinal (starts from 1)
`record_nr`	NDEF record ordinal (in message)
`tnf`	pointer to the variable containing TNF of record
`type_record`	pointer to array containing type of record
`type_length`	pointer to the variable containing length of type of record string
`id`	pointer to array containing ID of record
`id_length`	pointer to the variable containing length of ID of record string
`payload`	pointer to array containing payload of record
`payload_length`	pointer to the variable containing length of payload

write_ndef_record

Function description

Function adds a record to the end of message, if one or more records already exist in this message. If current message is empty, then this empty record will be replaced with the record. Parameters of function are: ordinal of message, TNF, type of record, ID, payload. Function also returns pointer to the variable which reported that the card formatted for NDEF using (card does not have a capability container, for example new Mifare Ultralight, or Mifare Classic card).

Function declaration (C language)

```
UFR_STATUS write_ndef_record(uint8_t message_nr,
                             uint8_t *tnf,
                             uint8_t *type_record,
                             uint8_t *type_length,
                             uint8_t *id,
                             uint8_t *id_length,
                             uint8_t *payload,
                             uint32_t *payload_length,
                             uint8_t *card_formated);
```

Parameters

`message_nr`	NDEF message ordinal (starts from 1)
`tnf`	pointer to variable containing TNF of record
`type_record`	pointer to array containing type of record
`type_length`	pointer to the variable containing length of type of record string
`id`	pointer to array containing ID of record
`id_length`	pointer to the variable containing length of ID of record string
`payload`	pointer to array containing payload of record
`payload_length`	pointer to the variable containing length of payload
`card_formated`	pointer to the variable which shows that the card formatted for NDEF using.

write_ndef_record_mirroring
write_ndef_record_mirroring_tt

Function description

This function works the same as the **`write_ndef_record()`**, with the additional “UID and / or NFC counter mirror” features support. NTAG 21x family of devices offers these specific features. For details about “ASCII mirror” features refer to http://www.nxp.com/docs/en/data-sheet/NTAG213_215_216.pdf (in Rev. 3.2 from 2. June 2015, page 20) and http://www.nxp.com/docs/en/data-sheet/NTAG210_212.pdf (in Rev. 3.0 from 14. March 2013, page 16).

Function declaration (C language)

```
UFR_STATUS write_ndef_record_mirroring(uint8_t message_nr,
                                       uint8_t *tnf,
                                       uint8_t *type_record,
                                       uint8_t *type_length,
                                       uint8_t *id,
                                       uint8_t *id_length,
                                       uint8_t *payload,
                                       uint32_t *payload_length,
                                       uint8_t *card_formated,
                                       int use_uid_ascii_mirror,
                                       int use_counter_ascii_mirror,
                                       uint32_t payload_mirroring_pos);
```

Parameters

`message_nr`	NDEF message ordinal (starts from 1)
`tnf`	pointer to variable containing TNF of record
`type_record`	pointer to array containing type of record
`type_length`	pointer to the variable containing length of type of record string
`id`	pointer to array containing ID of record
`id_length`	pointer to the variable containing length of ID of record string
`payload`	pointer to array containing payload of record
`payload_length`	pointer to the variable containing length of payload
`card_formated`	pointer to the variable which shows that the card formatted for NDEF using.
`use_uid_ascii_mirror`	if `use_uid_ascii_mirror == 1` then “UID ASCII Mirror”

	feature is in use. if `use_uid_ascii_mirror == 0` then "UID ASCII Mirror" feature is switched off.
`use_counter_ascii_mirror`	if `use_counter_ascii_mirror == 1` then "NFC counter ASCII Mirror" feature is in use. if `use_counter_ascii_mirror == 0` then "NFC counter ASCII Mirror" feature is switched off.
`payload_mirroring_pos`	Defines the starting position of the "ASCII Mirror" into the NDEF record payload.

From library version 5.0.59 and firmware version 5.0.60. NTAG 213 TT support. Parameter use_tt_message_mirror added.

```
UFR_STATUS write_ndef_record_mirroring_tt(uint8_t message_nr,
                                      uint8_t *tnf,
                                      uint8_t *type_record,
                                      uint8_t *type_length,
                                      uint8_t *id,
                                      uint8_t *id_length,
                                      uint8_t *payload,
                                      uint32_t *payload_length,
                                      uint8_t *card_formated,
                                      int use_uid_ascii_mirror,
                                      int use_counter_ascii_mirror,
                                      int use_tt_message_mirror,
                                      uint32_t payload_mirroring_pos);
```

erase_last_ndef_record

Function description

Function deletes the last record of the selected message. If a message contains one record, then it will be written as an empty message.

Function declaration (C language)

```
UFR_STATUS erase_last_ndef_record(uint8_t message_nr);
```

Parameter

`message_nr`	NDEF message ordinal (starts form 1)

erase_all_ndef_records

Function description

Function deletes all records of the message, then writes an empty message.

Function declaration (C language)

```
UFR_STATUS erase_all_ndef_records(uint8_t message_nr);
```

Parameter

message_nr	NDEF message ordinal (starts form 1)

ndef_card_initialization

Function description

Function prepares the card for NDEF using. Function writes Capability Container (CC) if necessary, and writes empty message. If the card is MIFARE CLASSIC or MIFARE PLUS, then the function writes MAD (MIFARE Application Directory), and default keys and access bits for NDEF using.

Function declaration (C language)

```
UFR_STATUS ndef_card_initialization(void);
```

ERROR CODES OF NDEF FUNCTIONS

```
UFR_WRONG_NDEF_CARD_FORMAT = 0x80
UFR_NDEF_MESSAGE_NOT_FOUND = 0x81
UFR_NDEF_UNSUPPORTED_CARD_TYPE = 0x82
UFR_NDEF_CARD_FORMAT_ERROR = 0x83
UFR_MAD_NOT_ENABLED = 0x84
UFR_MAD_VERSION_NOT_SUPPORTED = 0x85
```

Functions for configuration of asynchronously card ID sending

When the card put on the reader, then the string which contains card ID shall be sent. String contains hexadecimal notation of card ID, after that is one mandatory suffix character. Before the card ID may be one prefix character placed.

Example:

Card ID is 0xA103C256, prefix is 0x58 ('X'), suffix is 0x59 ('Y')

String is “XA103C256Y”

SetAsyncCardIdSendConfig

Function description

Function sets the parameters of card ID sending. Parameters are: prefix existing, prefix character, suffix character, and baud rate for card ID sending.

Function declaration (C language)

```
UFR_STATUS SetAsyncCardIdSendConfig(uint8_t send_enable,
                                    uint8_t prefix_enable,
                                    uint8_t prefix,
                                    uint8_t suffix,
                                    uint32_t async_baud_rate);
```

Parameters

`send_enable`	sending enable flag (0 – disabled, 1 – enabled)
`prefix_enable`	prefix existing flag (0 – prefix don't exist, 1 – prefix exist)
`prefix`	prefix character
`suffix`	suffix character
`async_baud_rate`	baud rate value (e.g. 9600)

GetAsyncCardIdSendConfig

Function description

Function returns the parameters of card ID sending.

Function declaration (C language)

```
UFR_STATUS GetAsyncCardIdSendConfig(uint8_t *send_enable,
                                    uint8_t *prefix_enable,
                                    uint8_t *prefix,
                                    uint8_t *suffix,
                                    uint32_t *async_baud_rate);
```

Parameters

`send_enable`	pointer to the sending enable flag
`prefix_enable`	pointer to the prefix existing flag
`prefix`	pointer to the prefix variable
`suffix`	pointer to the suffix variable
`async_baud_rate`	pointer to the baud rate variable

Functions that works with Real Time Clock (RTC)

RTC embedded in uFR Advance device only.

GetReaderTime

Function description

Function returns 6 bytes array of uint8_t that represented current date and time into device's RTC.

- Byte 0 represent year (current year – 2000)
- Byte 1 represent month (1 – 12)
- Byte 2 represent day of the month (1 – 31)
- Byte 3 represent hour (0 – 23)
- Byte 4 represent minute (0 – 59)
- Byte 5 represent second (0 – 59)

Function declaration (C language)

```
UFR_STATUS GetReaderTime(uint8_t *time);
```

Parameter

`time`	pointer to the array containing current date and time representation

SetReaderTime

Function description

Function sets the date and time into device's RTC. Function requires the 8 bytes password entry to set date and time. Date and time are represent into 6 bytes array in same way as in GetReaderTime function. Factory password is “11111111” (0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31).

Function declaration (C language)

```
UFR_STATUS SetReaderTime(uint8_t *password,
                         uint8_t *time);
```

Parameters

`password`	pointer to the 8 bytes array containing password
`time`	pointer to the 6 bytes array containing date and time representation

ChangeReaderPassword

Function description

Function changes password for set date and time. Function's parameters are old password and new password.

Function declaration (C language)

```
UFR_STATUS ChangeReaderPassword(uint8_t *old_password,
                                uint8_t *new_password);
```

Parameters

`old_password`	pointer to the 8 bytes array containing current password
`new_password`	pointer to the 8 bytes array containing new password

Functions that works with EEPROM

EEPROM embedded in uFR Advance device only.

Range of user address is from 0 to 32750.

ReaderEepromRead

Function description

Function returns array of data read from EEPROM. Maximal length of array is 128 bytes.

Function declaration (C language)

```
UFR_STATUS ReaderEepromRead(uint8_t *data,
                            uint32_t address,
                            uint32_t size);
```

Parameters

data	pointer to array containing data from EEPROM
address	address of first data
size	length of array

ReaderEepromWrite

Function description

Function writes array of data into EEPROM. Maximal length of array is 128 bytes. Function requires password which length is 8 bytes. Factory password is “11111111” (0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31).

Function declaration (C language)

```
UFR_STATUS ReaderEepromWrite(uint8_t *data,
                             uint32_t address,
                             uint32_t size,
                             uint8_t *password);
```

Parameters

data	pointer to array containing data
address	address of first data
size	length of array
password	pointer to array containing password

Functions that works with Mifare Desfire Card (AES encryption in reader)

AES encryption and decryption is performed in the reader. AES keys are stored into reader.

uFR_int_WriteAesKey
uFR_int_DesfireWriteKey

Function description

Function writes AES key (16 bytes) into reader.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireWriteAesKey(uint8_t aes_key_no,
                                      uint8_t *aes_key);
```

Parameters

aes_key_no	ordinal number of AES key in the reader (0 - 15)
aes_key	pointer to 16 byte array containing the AES key

For uFR PLUS devices only

Function description

Function writes key into reader. There are 4 types of keys, and they enumerated

```
enum KEY_TYPE
{
     AES_KEY_TYPE = 0,   //AES 16 bytes
     DES3K_KEY_TYPE = 1,      //3K3DES 24 bytes
     DES_KEY_TYPE = 2,   //DES 8 bytes
     DES2K_KEY_TYPE = 3 //2K3DES 16 bytes
};
```

The 3K3DES key takes two fields into reader. For example if 3K3DES key stored at field 0, then the field 1 occupied. Next key may be stored into field 2.

```
UFR_STATUS uFR_int_DesfireWriteKey(uint8_t key_no,
                                   uint8_t *key,
                                   uint8_t key_type);
```

Parameters

key_no	ordinal number of key in the reader (0 - 15)
key	pointer to array containing the key

key_type	enumerated key type (0 - 3)

uFR_int_GetDesfireUid (deprecated)
uFR_int_GetDesfireUid_PK (deprecated)
uFR_int_GetDesfireUid_aes (alias for uFR_int_GetDesfireUid)
uFR_int_GetDesfireUid_des
uFR_int_GetDesfireUid_2k3des
uFR_int_GetDesfireUid_3k3des
uFR_int_GetDesfireUid_aes_PK(alias for uFR_int_GetDesfireUid_PK)
uFR_int_GetDesfireUid_des_PK
uFR_int_GetDesfireUid_2k3des_PK
uFR_int_GetDesfireUid_3k3des_PK
uFR_SAM_GetDesfireUidAesAuth
uFR_SAM_GetDesfireUidDesAuth
uFR_SAM_GetDesfireUid2k3desAuth
uFR_SAM_GetDesfireUid3k3desAuth

Function description

Mifare Desfire EV1 card can be configured to use Random ID numbers instead Unique ID numbers during anti-collision procedure. In this case card uses single anti-collision loop, and returns Random Number Tag 0x08 and 3 bytes Random Number (4 bytes Random ID). This function returns Unique ID of card, if the Random ID is used.

From library version 5.0.29. and firmware version 5.0.32, Desfire Light card supported.

Function declaration (C language)

```
UFR_STATUS uFR_int_GetDesfireUid(uint8_t aes_key_nr,
                                 uint32_t aid,
                                 uint8_t aid_key_nr,
                                 uint8_t *card_uid,
                                 uint8_t *card_uid_len,
                                 uint16_t *card_status,
                                 uint16_t *exec_time);
UFR_STATUS uFR_int_GetDesfireUid_PK(uint8_t *aes_key_ext,
                                    uint32_t aid,
                                    uint8_t aid_key_nr,
                                    uint8_t *card_uid,
                                    uint8_t *card_uid_len,
                                    uint16_t *card_status,
                                    uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```
UFR_STATUS uFR_int_GetDesfireUid_aes(uint8_t aes_key_nr,
                                 uint32_t aid,
                                 uint8_t aid_key_nr,
                                 uint8_t *card_uid,
                                 uint8_t *card_uid_len,
                                 uint16_t *card_status,
                                 uint16_t *exec_time);
UFR_STATUS uFR_int_GetDesfireUid_des(uint8_t des_key_nr,
                                   uint32_t aid,
                                   uint8_t aid_key_nr,
                                   uint8_t *card_uid,
                                   uint8_t *card_uid_len,
                                   uint16_t *card_status,
                                   uint16_t *exec_time);
UFR_STATUS uFR_int_GetDesfireUid_2k3des(uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t *card_uid,
                                        uint8_t *card_uid_len,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_GetDesfireUid_3k3des(uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t *card_uid,
                                        uint8_t *card_uid_len,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_GetDesfireUid_aes_PK(uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t *card_uid,
                                        uint8_t *card_uid_len,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_GetDesfireUid_des_PK(uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t *card_uid,
                                        uint8_t *card_uid_len,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
UFR_STATUS uFR_int_GetDesfireUid_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t *card_uid,
                                        uint8_t *card_uid_len,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_GetDesfireUid_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t *card_uid,
                                        uint8_t *card_uid_len,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
*only uFR CS with SAM support
```

```
UFR_STATUS uFR_SAM_GetDesfireUidAesAuth(uint8_t aes_key_nr,
                                 uint32_t aid,
                                 uint8_t aid_key_nr,
                                 uint8_t *card_uid,
                                 uint8_t *card_uid_len,
                                 uint16_t *card_status,
                                 uint16_t *exec_time);
UFR_STATUS uFR_SAM_GetDesfireUidDesAuth(uint8_t des_key_nr,
                                   uint32_t aid,
                                   uint8_t aid_key_nr,
                                   uint8_t *card_uid,
                                   uint8_t *card_uid_len,
                                   uint16_t *card_status,
                                   uint16_t *exec_time);
UFR_STATUS uFR_SAM_GetDesfireUid2k3desAuth(uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t *card_uid,
                                        uint8_t *card_uid_len,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_GetDesfireUid3k3desAuth(uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t *card_uid,
                                        uint8_t *card_uid_len,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aid	ID of application that uses this key (3 bytes long, 0x000000 for card master key)
aid_key_nr	key number into application (0 for card master key or application master key)
card_uid	pointer to array containing card UID
card_uid_len	pointer to card UID length variable
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireFreeMem

Function description

Function returns the available bytes on the card.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireFreeMem(uint32_t *free_mem_byte,
                                  uint16_t *card_status,
                                  uint16_t *exec_time);
```

Parameters

free_mem_byte	pointer to free memory size variable
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireFormatCard (deprecated)
uFR_int_DesfireFormatCard_PK (deprecated)
uFR_int_DesfireFormatCard_aes (alias for uFR_int_DesfireFormatCard)
uFR_int_DesfireFormatCard_des
uFR_int_DesfireFormatCard_2k3des
uFR_int_DesfireFormatCard_3k3des
uFR_int_DesfireFormatCard_aes_PK (alias for uFR_int_DesfireFormatCard_PK)
uFR_int_DesfireFormatCard_des_PK
uFR_int_DesfireFormatCard_2k3des_PK
uFR_int_DesfireFormatCard_3k3des_PK
uFR_SAM_DesfireFormatCardAesAuth
uFR_SAM_DesfireFormatCardDesAuth
uFR_SAM_DesfireFormatCard2k3desAuth
uFR_SAM_DesfireFormatCard3k3desAuth

Function description

Function releases all allocated user memory on the card. All applications will be deleted, also all files within those applications will be deleted. Only the card master key, and card master key settings will not be deleted. This operation requires authentication with the card master key.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireFormatCard(uint8_t aes_key_nr,
                                     uint16_t *card_status,
                                     uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireFormatCard_PK(uint8_t *aes_key_ext,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```
UFR_STATUS uFR_int_DesfireFormatCard_aes(
                                        uint8_t aes_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireFormatCard_des(
                                        uint8_t des_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireFormatCard_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireFormatCard_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireFormatCard_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireFormatCard_des_PK(
                                        uint8_t *des_key_ext,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireFormatCard_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireFormatCard_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);

*only uFR CS with SAM support
UFR_STATUS uFR_SAM_DesfireFormatCardAesAuth(
                                        uint8_t aes_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireFormatCardDesAuth(
                                        uint8_t des_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireFormatCard2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireFormatCard3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireSetConfiguration (deprecated)
uFR_int_DesfireSetConfiguration_PK (deprecated)
uFR_int_DesfireSetConfiguration_aes (alias for uFR_int_DesfireSetConfiguration)
uFR_int_DesfireSetConfiguration_des
uFR_int_DesfireSetConfiguration_2k3des
uFR_int_DesfireSetConfiguration_3k3des
uFR_int_DesfireSetConfiguration_aes_PK (alias for uFR_int_DesfireSetConfiguration_PK)
uFR_int_DesfireSetConfiguration_des_PK
uFR_int_DesfireSetConfiguration_2k3des_PK
uFR_int_DesfireSetConfiguration_3k3des_PK
uFR_SAM_DesfireSetConfigurationAesAuth
uFR_SAM_DesfireSetConfigurationDesAuth
uFR_SAM_DesfireSetConfiguration2k3desAuth
uFR_SAM_DesfireSetConfiguration3k3desAuth

Function description

Function allows you to activate the Random ID option, and/or Format disable option. If these options are activated, then they can not be returned to the factory setting (Random ID disabled, Format card enabled). This operation requires authentication with the card master key.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireSetConfiguration(uint8_t aes_key_nr,
                                           uint8_t random_uid,
                                           uint8_t format_disable,
                                           uint16_t *card_status,
                                           uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireSetConfiguration_PK(uint8_t *aes_key_ext,
                                              uint8_t random_uid,
                                              uint8_t format_disable,
                                              uint16_t *card_status,
                                              uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```
UFR_STATUS uFR_int_DesfireSetConfiguration_aes(
                                        uint8_t aes_key_nr,
                                        uint8_t random_uid,
                                        uint8_t format_disable,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireSetConfiguration_des(
                                        uint8_t des_key_nr,
                                        uint8_t random_uid,
                                        uint8_t format_disable,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireSetConfiguration_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint8_t random_uid,
                                        uint8_t format_disable,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireSetConfiguration_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint8_t random_uid,
                                        uint8_t format_disable,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireSetConfiguration_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint8_t random_uid,
                                        uint8_t format_disable,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireSetConfiguration_des_PK(
                                        uint8_t *des_key_ext,
                                        uint8_t random_uid,
                                        uint8_t format_disable,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireSetConfiguration_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint8_t random_uid,
                                        uint8_t format_disable,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireSetConfiguration_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint8_t random_uid,
                                        uint8_t format_disable,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);

*only uFR CS with SAM support
```

```
UFR_STATUS uFR_SAM_DesfireSetConfigurationAesAuth(
                                        uint8_t aes_key_nr,
                                        uint8_t random_uid,
                                        uint8_t format_disable,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireSetConfigurationDesAuth(
                                        uint8_t des_key_nr,
                                        uint8_t random_uid,
                                        uint8_t format_disable,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireSetConfiguration2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint8_t random_uid,
                                        uint8_t format_disable,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireSetConfiguration3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint8_t random_uid,
                                        uint8_t format_disable,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
random_uid	0 – Random ID disabled, 1 – Random ID enabled
format_disable	0 – Format enabled, 1 – Format disabled
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireGetKeySettings (deprecated)
uFR_int_DesfireGetKeySettings_PK (deprecated)
uFR_int_DesfireGetKeySettings_aes (alias for uFR_int_DesfireGetKeySettings)
uFR_int_DesfireGetKeySettings_des
uFR_int_DesfireGetKeySettings_2k3des
uFR_int_DesfireGetKeySettings_3k3des
uFR_int_DesfireGetKeySettings_aes_PK (alias for uFR_int_DesfireGetKeySettings_PK)
uFR_int_DesfireGetKeySettings_des_PK
uFR_int_DesfireGetKeySettings_2k3des_PK
uFR_int_DesfireGetKeySettings_3k3des_PK
uFR_SAM_DesfireGetKeySettingsAesAuth
uFR_SAM_DesfireGetKeySettingsDesAuth
uFR_SAM_DesfireGetKeySettings2k3desAuth
uFR_SAM_DesfireGetKeySettings3k3desAuth
uFR_int_DesfireGetKeySettings_no_auth

Function description

Function allows to get card master key and application master key configuration settings. In addition it returns the maximum number of keys which can be stored within selected application. Is the authentication with master key required, depends of master key setting.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireGetKeySettings(uint8_t aes_key_nr,
                                         uint32_t aid,
                                         uint8_t *settings
                                         uint8_t *max_key_no,
                                         uint16_t *card_status,
                                         uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetKeySettings_PK(uint8_t *aes_key_ext,
                                            uint32_t aid,
                                            uint8_t *settings
                                            uint8_t *max_key_no,
                                            uint16_t *card_status,
                                            uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```
UFR_STATUS uFR_int_DesfireGetKeySettings_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t *setting,
                                        uint8_t *max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetKeySettings_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t *setting,
                                        uint8_t *max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetKeySettings_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t *setting,
                                        uint8_t *max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetKeySettings_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t *setting,
                                        uint8_t *max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetKeySettings_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t *setting,
                                        uint8_t *max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetKeySettings_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t *setting,
                                        uint8_t *max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
UFR_STATUS uFR_int_DesfireGetKeySettings_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t *setting,
                                        uint8_t *max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetKeySettings_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t *setting,
                                        uint8_t *max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
*only uFR CS with SAM support
UFR_STATUS uFR_SAM_DesfireGetKeySettingsAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t *setting,
                                        uint8_t *max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireGetKeySettingsDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t *setting,
                                        uint8_t *max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireGetKeySettings2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t *setting,
                                        uint8_t *max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireGetKeySettings3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t *setting,
                                        uint8_t *max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
From library version 5.0.36 and firmware version 5.0.37
UFR_STATUS uFR_int_DesfireGetKeySettings_no_auth(
                                        uint32_t aid,
                                        uint8_t *setting,
                                        uint8_t *max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aid	ID of application that uses this key (3 bytes long, 0x000000 for card master key)
settings	pointer to settings variable
max_key_no	maximum number of keys within selected application
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireChangeKeySettings (deprecated)
uFR_int_DesfireChangeKeySettings_PK (deprecated)
uFR_int_DesfireChangeKeySettings_aes (alias for uFR_int_DesfireChangeKeySettings)
uFR_int_DesfireChangeKeySettings_des
uFR_int_DesfireChangeKeySettings_2k3des
uFR_int_DesfireChangeKeySettings_3k3des
uFR_int_DesfireChangeKeySettings_aes_PK (alias for uFR_int_DesfireChangeKeySettings_PK)
uFR_int_DesfireChangeKeySettings_des_PK
uFR_int_DesfireChangeKeySettings_2k3des_PK
uFR_int_DesfireChangeKeySettings_3k3des_PK
uFR_SAM_DesfireChangeKeySettingsAesAuth
uFR_SAM_DesfireChangeKeySettingsDesAuth
uFR_SAM_DesfireChangeKeySettings2k3desAuth
uFR_SAM_DesfireChangeKeySettings3k3desAuth

Function description

Function allows to set card master key, and application master key configuration settings.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireChangeKeySettings(uint8_t aes_key_nr,
                                            uint32_t aid,
                                            uint8_t settings,
                                            uint16_t *card_status,
                                            uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeKeySettings_PK(uint8_t *aes_key_ext,
                                               uint32_t aid,
                                               uint8_t settings,
                                               uint16_t *card_status,
                                               uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```
UFR_STATUS uFR_int_DesfireChangeKeySettings_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeKeySettings_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeKeySettings_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeKeySettings_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeKeySettings_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeKeySettings_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
UFR_STATUS uFR_int_DesfireChangeKeySettings_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeKeySettings_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

***only uFR CS with SAM support**

```
UFR_STATUS uFR_SAM_DesfireChangeKeySettingsAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireChangeKeySettingsDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireChangeKeySettings2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireChangeKeySettings3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key

`des3k_key_ext`	pointer to 24 bytes array containing the 3K3DES key
`aid`	ID of application that uses this key (3 bytes long, 0x000000 for card master key)
`settings`	pointer to key settings variable
`card_status`	pointer to card error variable
`exec_time`	function's execution time

uFR_int_DesfireChangeAesKey
uFR_int_DesfireChangeAesKey_PK (deprecated)
uFR_int_DesfireChangeAesKey_A (deprecated)
uFR_int_DesfireChangeAesKey_aes (alias for uFR_int_DesfireChangeAesKey_A)
uFR_int_DesfireChangeDesKey_des
uFR_int_DesfireChange2K3DesKey_des
uFR_int_DesfireChangeDesKey_2k3des
uFR_int_DesfireChange2K3DesKey_2k3des
uFR_int_DesfireChange3K3DesKey_3k3des
uFR_int_DesfireChangeMasterKey
uFR_int_DesfireChangeAesKey_aes_PK (alias for uFR_int_DesfireChangeAesKey_PK)
uFR_int_DesfireChangeDesKey_des_PK
uFR_int_DesfireChange2K3DesKey_des_PK
uFR_int_DesfireChangeDesKey_2k3des_PK
uFR_int_DesfireChange2K3DesKey_2k3des_PK
uFR_int_DesfireChange3K3DesKey_3k3des_PK
uFR_int_DesfireChangeMasterKey_PK
uFR_SAM_DesfireChangeAesKey_AesAuth
uFR_SAM_DesfireChangeDesKey_DesAuth
uFR_SAM_DesfireChange2k3desKey_DesAuth
uFR_SAM_DesfireChangeDesKey_2k3desAuth
uFR_SAM_DesfireChange2k3desKey_2k3desAuth
uFR_SAM_DesfireChange3k3desKey_3k3desAuth
uFR_SAM_DesfireChangeMasterKey

Function description
Function allows you to change any AES key on the card. Changing the card master key requires current card master key authentication. Authentication for the application keys changing depends on the application master key settings (which key is used for authentication).

Important: When changing a card key to a 2K3DES key, the new 2K3DES key must have different first 8 bytes and second 8 bytes. For example, the new 2K3DES key should be: **11111111111111112222222222222222.** New 2K3DES key **must not** consist of all zeros (16 0x00 bytes).

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireChangeAesKey(uint8_t aes_key_nr,
                                       uint32_t aid,
                                       uint8_t aid_key_nr_auth,
                                       uint8_t new_aes_key[16],
                                       uint8_t aid_key_no,
                                       uint8_t old_aes_key[16],
                                       uint16_t *card_status,
                                       uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeAesKey_PK(uint8_t *aes_key_ext,
                                          uint32_t aid,
                                          uint8_t aid_key_nr_auth,
                                          uint8_t new_aes_key[16],
                                          uint8_t aid_key_no,
                                          uint8_t old_aes_key[16],
                                          uint16_t *card_status,
                                          uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeAesKey_A(uint8_t aes_key_nr,
                                         uint32_t aid,
                                         uint8_t aid_key_no_auth,
                                         uint8_t new_aes_key_nr,
                                         uint8_t aid_key_no,
                                         uint8_t old_aes_key_nr,
                                         uint16_t *card_status,
                                         uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```
UFR_STATUS uFR_int_DesfireChangeAesKey_aes(uint8_t aes_key_nr,
                                         uint32_t aid,
                                         uint8_t aid_key_no_auth,
                                         uint8_t new_aes_key_nr,
                                         uint8_t aid_key_no,
                                         uint8_t old_aes_key_nr,
                                         uint16_t *card_status,
                                         uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeDesKey_des(
                                        uint8_t auth_des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_des_key_nr,
                                        uint8_t aid_key_no,
                                        uint8_t old_des_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChange2K3DesKey_des(
                                        uint8_t auth_des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_2k3des_key_nr,
                                        uint8_t aid_key_no,
                                        uint8_t old_2k3des_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeDesKey_2k3des(
                                        uint8_t auth_des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_des_key_nr,
                                        uint8_t aid_key_no,
                                        uint8_t old_des_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChange2K3DesKey_2k3des(
                                        uint8_t auth_des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_2k3des_key_nr,
                                        uint8_t aid_key_no,
                                        uint8_t old_2k3des_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChange3K3DesKey_3k3des(
                                        uint8_t auth_des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_3k3des_key_nr,
                                        uint8_t aid_key_no,
                                        uint8_t old_3k3des_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeMasterKey(
                                        uint8_t auth_key_nr,
                                        uint8_t auth_key_type,
                                        uint8_t new_key_nr,
                                        uint8_t new_key_type,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeAesKey_aes_PK(uint8_t *aes_key_ext,
                                          uint32_t aid,
                                          uint8_t aid_key_nr_auth,
                                          uint8_t new_aes_key[16],
                                          uint8_t aid_key_no,
                                          uint8_t old_aes_key[16],
                                          uint16_t *card_status,
                                          uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeDesKey_des_PK(
                                        uint8_t *auth_des_key,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_des_key[8],
                                        uint8_t aid_key_no,
                                        uint8_t old_des_key[8],
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChange2K3DesKey_des_PK(
                                        uint8_t *auth_des_key,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_2k3des_key[16],
                                        uint8_t aid_key_no,
                                        uint8_t old_2k3des_key[16],
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeDesKey_2k3des_PK(
                                        uint8_t *auth_des2k_key,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_des_key[8],
                                        uint8_t aid_key_no,
                                        uint8_t old_des_key[8],
                                        uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChange2K3DesKey_2k3des_PK(
                                        uint8_t *auth_des2k_key,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_2k3des_key[16],
                                        uint8_t aid_key_no,
                                        uint8_t old_2k3des_key[16],
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChange3K3DesKey_3k3des_PK(
                                        uint8_t *auth_des3k_key,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_3k3des_key[24],
                                        uint8_t aid_key_no,
                                        uint8_t old_3k3des_key[24],
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireChangeMasterKey_PK(
                                        uint8_t *auth_key,
                                        uint8_t auth_key_type,
                                        uint8_t *new_key,
                                        uint8_t new_key_type,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);

*only uFR CS with SAM support
UFR_STATUS uFR_SAM_DesfireChangeAesKey_AesAuth(uint8_t aes_key_nr,
                                         uint32_t aid,
                                         uint8_t aid_key_no_auth,
                                         uint8_t new_aes_key_nr,
                                         uint8_t aid_key_no,
                                         uint8_t old_aes_key_nr,
                                         uint16_t *card_status,
                                         uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireChangeDesKey_DesAuth(
                                        uint8_t auth_des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_des_key_nr,
                                        uint8_t aid_key_no,
                                        uint8_t old_des_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireChange2k3desKey_DesAuth(
                                        uint8_t auth_des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_2k3des_key_nr,
                                        uint8_t aid_key_no,
                                        uint8_t old_2k3des_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireChangeDesKey_2k3desAuth(
                                        uint8_t auth_des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_des_key_nr,
                                        uint8_t aid_key_no,
                                        uint8_t old_des_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireChange2k3desKey_2k3desAuth(
                                        uint8_t auth_des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_2k3des_key_nr,
                                        uint8_t aid_key_no,
                                        uint8_t old_2k3des_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireChange3k3desKey_3k3desAuth(
                                        uint8_t auth_des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_no_auth,
                                        uint8_t new_3k3des_key_nr,
                                        uint8_t aid_key_no,
                                        uint8_t old_3k3des_key_nr,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireChangeMasterKey(
                                        uint8_t auth_key_nr,
                                        uint8_t auth_key_type,
                                        uint8_t new_key_nr,
                                        uint8_t new_key_type,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **auth_des_key_nr** **auth_des2k_key** **auth_des3k_key_nr**	ordinal number of authentication AES key in the reader ordinal number of authentication DES key in the reader ordinal number of authentication 2K3DES key in the reader ordinal number of authentication 3K3DES key in the reader
aes_key_ext **auth_des_key** **auth_des2k_key** **auth_des3k_key**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 32 bytes array containing the 3K3DES key
aid	ID of application that uses this key (3 bytes long, 0x000000 for card

	master key)
aid_key_nr_auth	key number into application which uses for authentication
new_aes_key[16] **new_des_key[8]** **new_2k3des_key[16]** **new_3k3des_key[24]**	16 bytes array that represent AES key 8 bytes array that represent DES key 16 bytes array that represent 2K3DES key 24 bytes array that represent 3K3DES key
aid_key_no	key number into application that will be changed
old_aes_key[16] **old_des_key[8]** **old_2k3des_key[16]** **old_3k3des_key[24]**	16 bytes array that represent current AES key that will be changed, if this is not key by which is made authentication
auth_key_type **new_key_type**	**AES_KEY_TYPE = 0, //AES 16 bytes** **DES3K_KEY_TYPE = 1, //3K3DES 24 bytes** **DES_KEY_TYPE = 2, //DES 8 bytes** **DES2K_KEY_TYPE = 3 //2K3DES 16 bytes**
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireCreateAesApplication (deprecated)
uFR_int_DesfireCreateAesApplication_PK (deprecated)
uFR_int_DesfireCreateAesApplication_no_auth
uFR_int_DesfireCreateAesApplication_aes (alias for uFR_int_DesfireCreateAesApplication)
uFR_int_DesfireCreateDesApplication_aes
uFR_int_DesfireCreate3k3desApplication_aes
uFR_int_DesfireCreateAesApplication_des
uFR_int_DesfireCreateDesApplication_des
uFR_int_DesfireCreate3k3desApplication_des
uFR_int_DesfireCreateAesApplication_2k3des
uFR_int_DesfireCreateDesApplication_2k3des
uFR_int_DesfireCreate3k3desApplication_2k3des
uFR_int_DesfireCreateAesApplication_3k3des
uFR_int_DesfireCreateDesApplication_3k3des
uFR_int_DesfireCreate3k3desApplication_3k3des
uFR_int_DesfireCreateAesApplication_aes_PK (alias for FR_int_DesfireCreateAesApplication_PK)
uFR_int_DesfireCreateDesApplication_aes_PK
uFR_int_DesfireCreate3k3desApplication_aes_PK
uFR_int_DesfireCreateAesApplication_des_PK
uFR_int_DesfireCreateDesApplication_des_PK
uFR_int_DesfireCreate3k3desApplication_des_PK
uFR_int_DesfireCreateAesApplication_2k3des_PK
uFR_int_DesfireCreateDesApplication_2k3des_PK
uFR_int_DesfireCreate3k3desApplication_2k3des_PK
uFR_int_DesfireCreateAesApplication_3k3des_PK
uFR_int_DesfireCreateDesApplication_3k3des_PK
uFR_int_DesfireCreate3k3desApplication_3k3des_PK
uFR_SAM_DesfireCreateAesApplicationAesAuth
uFR_SAM_DesfireCreateDesApplicationAesAuth
uFR_SAM_DesfireCreate3k3desApplicationAesAuth
uFR_SAM_DesfireCreateAesApplicationDesAuth
uFR_SAM_DesfireCreateDesApplicationDesAuth
uFR_SAM_DesfireCreate3k3desApplicationDesAuth
uFR_SAM_DesfireCreateAesApplication2k3desAuth
uFR_SAM_DesfireCreateDesApplication2k3desAuth
uFR_SAM_DesfireCreate3k3desApplication2k3desAuth
uFR_SAM_DesfireCreateAesApplication3k3desAuth
uFR_SAM_DesfireCreateDesApplication3k3desAuth
uFR_SAM_DesfireCreate3k3desApplication3k3desAuth

Function description

Function allows to create a new application on the card. Is the card master key authentication is required, depending on the card master key settings. Maximal number of applications on the card is 28. Each application is linked to set of up 14 different user definable access keys.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireCreateAesApplication(uint8_t aes_key_nr,
                                               uint32_t aid_nr,
                                               uint8_t setting,
                                               uint8_t max_key_no,
                                               uint16_t *card_status,
                                               uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateAesApplication_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateAesApplication_no_auth(
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```
UFR_STATUS uFR_int_DesfireCreateAesApplication_aes(uint8_t aes_key_nr,
                                               uint32_t aid_nr,
                                               uint8_t setting,
                                               uint8_t max_key_no,
                                               uint16_t *card_status,
                                               uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreate3k3desApplication_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateDesApplication_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateAesApplication_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
UFR_STATUS uFR_int_DesfireCreate3k3desApplication_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateDesApplication_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateAesApplication_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreate3k3desApplication_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateDesApplication_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateAesApplication_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreate3k3desApplication_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateDesApplication_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreate3k3desApplication_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateAesApplication_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateDesApplication_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateAesApplication_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreate3k3desApplication_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateDesApplication_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateAesApplication_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreate3k3desApplication_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateDesApplication_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateAesApplication_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreate3k3desApplication_des_PK(
                                        IN uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateDesApplication_des_PK(
                                        IN uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);

*only uFR CS with SAM support
UFR_STATUS uFR_SAM_DesfireCreateAesApplicationAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid_nr,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateDesApplicationAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreate3k3desApplicationAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateAesApplicationDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
UFR_STATUS uFR_SAM_DesfireCreateDesApplicationDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreate3k3desApplicationDesAuth(
                                        uint8_t desk_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateAesApplication2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateDesApplication2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreate2k3desApplication2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateAesApplication3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateDesApplication3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreate3k3desApplication3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t setting,
                                        uint8_t max_key_no,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameter

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aid_nr	ID of application that creates (3 bytes long 0x000000 to 0xFFFFFF)
settings	application master key settings
max_key_no	maximal number of keys into application (1 to 14)
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireDeleteApplication (deprecated)
uFR_int_DesfireDeleteApplication_PK (deprecated)
uFR_int_DesfireDeleteApplication_aes (alias for uFR_int_DesfireDeleteApplication)
uFR_int_DesfireDeleteApplication_des
uFR_int_DesfireDeleteApplication_2k3des
uFR_int_DesfireDeleteApplication_3k3des
uFR_int_DesfireDeleteApplication_aes_PK (alias for uFR_int_DesfireDeleteApplication_PK)
uFR_int_DesfireDeleteApplication_des_PK
uFR_int_DesfireDeleteApplication_2k3des_PK
uFR_int_DesfireDeleteApplication_3k3des_PK
uFR_SAM_DesfireDeleteApplicationAesAuth
uFR_SAM_DesfireDeleteApplicationDesAuth
uFR_SAM_DesfireDeleteApplication2k3desAuth
uFR_SAM_DesfireDeleteApplication3k3desAuth
uFR_int_DesfireDeleteApplication_app_master_aes
uFR_int_DesfireDeleteApplication_app_master_des
uFR_int_DesfireDeleteApplication_app_master_2k3des
uFR_int_DesfireDeleteApplication_app_master_3k3des
uFR_int_DesfireDeleteApplication_app_master_aes_PK
uFR_int_DesfireDeleteApplication_app_master_des_PK
uFR_int_DesfireDeleteApplication_app_master_2k3des_PK
uFR_int_DesfireDeleteApplication_app_master_3k3des_PK
uFR_SAM_DesfireDeleteApplication_app_master_AesAuth
uFR_SAM_DesfireDeleteApplication_app_master_DesAuth
uFR_SAM_DesfireDeleteApplication_app_master_2k3desAuth
uFR_SAM_DesfireDeleteApplication_app_master_3k3desAuth

Function description
Function allows to deactivate application on the card. Is the authentication with card master key or with the application master key is required, depending on the card master key settings. AID allocation is removed, but deleted memory blocks can only recovered by using Format card function.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireDeleteApplication(uint8_t aes_key_nr,
                                            uint32_t aid_nr,
                                            uint16_t *card_status,
                                            uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_PK(uint8_t *aes_key_ext,
                                               uint32_t aid_nr,
                                               uint16_t *card_status,
                                               uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```
UFR_STATUS uFR_int_DesfireDeleteApplication_aes(uint8_t aes_key_nr,
                                                  uint32_t aid_nr,
                                                  uint16_t *card_status,
                                                  uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_des(
                                              uint8_t des_key_nr,
                                              uint32_t aid,
                                              uint16_t *card_status,
                                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_2k3des(
                                              uint8_t des2k_key_nr,
                                              uint32_t aid,
                                              uint16_t *card_status,
                                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_3k3des(
                                              uint8_t des3k_key_nr,
                                              uint32_t aid,
                                              uint16_t *card_status,
                                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_aes_PK(
                                              uint8_t *aes_key_ext,
                                              uint32_t aid,
                                              uint16_t *card_status,
                                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_des_PK(
                                              uint8_t *des_key_ext,
                                              uint32_t aid,
                                              uint16_t *card_status,
                                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_2k3des_PK(
                                              uint8_t *des2k_key_ext,
                                              uint32_t aid,
                                              uint16_t *card_status,
                                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_3k3des_PK(
                                              uint8_t *des3k_key_ext,
                                              uint32_t aid,
                                              uint16_t *card_status,
                                              uint16_t *exec_time);
```

***only uFR CS with SAM support**

```
UFR_STATUS uFR_SAM_DesfireDeleteApplicationAesAuth(uint8_t aes_key_nr,
                                                  uint32_t aid_nr,
                                                  uint16_t *card_status,
                                                  uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDeleteApplicationDesAuth(
                                              uint8_t des_key_nr,
                                              uint32_t aid,
                                              uint16_t *card_status,
                                              uint16_t *exec_time);
```

```
UFR_STATUS uFR_SAM_DesfireDeleteApplication2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDeleteApplication3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);

From library version 5.0.36 and firmware version 5.0.37
UFR_STATUS uFR_int_DesfireDeleteApplication_app_master_aes(uint8_t
aes_key_nr,
                                            uint32_t aid_nr,
                                            uint16_t *card_status,
                                            uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_app_master_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_app_master_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_app_master_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_app_master_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_app_master_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_app_master_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteApplication_app_master_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

`*only uFR CS with SAM support`

```
UFR_STATUS uFR_SAM_DesfireDeleteApplication_app_master_AesAuth(uint8_t
aes_key_nr,
                                                  uint32_t aid_nr,
                                                  uint16_t *card_status,
                                                  uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDeleteApplication_app_master_DesAuth(
                                              uint8_t des_key_nr,
                                              uint32_t aid,
                                              uint16_t *card_status,
                                              uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDeleteApplication_app_master_2k3desAuth(
                                              uint8_t des2k_key_nr,
                                              uint32_t aid,
                                              uint16_t *card_status,
                                              uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDeleteApplication_app_master_3k3desAuth(
                                              uint8_t des3k_key_nr,
                                              uint32_t aid,
                                              uint16_t *card_status,
                                              uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aid_nr	ID of application that deletes (3 bytes long 0x000000 to 0xFFFFFF)
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireCreateStdDataFile (deprecated)
uFR_int_DesfireCreateStdDataFile_PK (deprecated)
uFR_int_DesfireCreateStdDataFile_no_auth
uFR_int_DesfireCreateStdDataFile_aes (alias for uFR_int_DesfireCreateStdDataFile)
uFR_int_DesfireCreateStdDataFile_des
uFR_int_DesfireCreateStdDataFile_2k3des
uFR_int_DesfireCreateStdDataFile_3k3des
uFR_int_DesfireCreateStdDataFile_aes_PK (alias for uFR_int_DesfireCreateStdDataFile_PK)
uFR_int_DesfireCreateStdDataFile_des_PK
uFR_int_DesfireCreateStdDataFile_2k3des_PK
uFR_int_DesfireCreateStdDataFile_3k3des_PK
uFR_SAM_DesfireCreateStdDataFileAesAuth
uFR_SAM_DesfireCreateStdDataFileDesAuth
uFR_SAM_DesfireCreateStdDataFile2k3desAuth
uFR_SAM_DesfireCreateStdDataFile3k3desAuth

Function description

Function allows to create file for the storage unformatted user data within existing application on the card. Maximal number of files into application is 32. The file will be created in the currently selected application. Is the application master key authentication is required, depend on the application master key settings.
Communication settings define communication mode between reader and card. The communication modes are:
- plain communication communication settings value is 0x00
- plain communication secured by MACing communication settings value is 0x01
- fully enciphered communication communication settings value is 0x03

Access rights for read, write, read&write and changing, references certain key within application's keys (0 – 13). If value is 14, this means free access, independent of previous authentication. If value is 15, this means deny access (for example if write access is 15 then the file type is read only).

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireCreateStdDataFile(
                                   uint8_t aes_key_nr,
                                   uint32_t aid,
                                   uint8_t file_id,
                                   uint32_t file_size,
                                   uint8_t read_key_no,
                                   uint8_t write_key_no,
                                   uint8_t read_write_key_no,
                                   uint8_t change_key_no,
                                   uint8_t communication_settings,
                                   uint16_t *card_status,
                                   uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateStdDataFile_PK(
                                   uint8_t *aes_key_ext,
                                   uint32_t aid,
                                   uint8_t file_id,
                                   uint32_t file_size,
                                   uint8_t read_key_no,
                                   uint8_t write_key_no,
                                   uint8_t read_write_key_no,
                                   uint8_t change_key_no,
                                   uint8_t communication_settings,
                                   uint16_t *card_status,
                                   uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateStdDataFile_no_auth(
                                   uint32_t aid,
                                   uint8_t file_id,
                                   uint32_t file_size,
                                   uint8_t read_key_no,
                                   uint8_t write_key_no,
                                   uint8_t read_write_key_no,
                                   uint8_t change_key_no,
                                   uint8_t communication_settings,
                                   uint16_t *card_status,
                                   uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```
UFR_STATUS uFR_int_DesfireCreateStdDataFile_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t file_size,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateStdDataFile_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t file_size,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateStdDataFile_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t file_size,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateStdDataFile_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t file_size,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateStdDataFile_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t file_size,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateStdDataFile_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t file_size,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateStdDataFile_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t file_size,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateStdDataFile_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t file_size,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

***only uFR CS with SAM support**

```
UFR_STATUS uFR_SAM_DesfireCreateStdDataFileAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t file_size,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateStdDataFileDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t file_size,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateStdDataFile2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t file_size,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateStdDataFile3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t file_size,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

`aes_key_nr`
`des_key_nr`
`des2k_key_nr`
`des3k_key_nr`
	ordinal number of AES key in the reader
	ordinal number of DES key in the reader
	ordinal number of 2K3DES key in the reader
	ordinal number of 3K3DES key in the reader

`aes_key_ext`
`des_key_ext`
`des2k_key_ext`
`des3k_key_ext`
	pointer to 16 bytes array containing the AES key
	pointer to 8 bytes array containing the DES key
	pointer to 16 bytes array containing the 2K3DES key
	pointer to 24 bytes array containing the 3K3DES key

`aid`	ID of application that contains the file
`file_id`	ID of file that will be created (0 – 31)
`file_size`	file size in bytes
`read_key_no`	key for reading
`write_key_no`	key for writing
`read_write_key_no`	key for reading and writing
`change_key_no`	key for changing this setting
`communication_settings`	variable that contains communication settings
`card_status`	pointer to card error variable
`exec_time`	function's execution time

uFR_int_DesfireDeleteFile (deprecated)
uFR_int_DesfireDeleteFile_PK
uFR_int_DesfireDeleteFile_no_auth
uFR_int_DesfireDeleteFile_aes (alias for uFR_int_DesfireDeleteFile)
uFR_int_DesfireDeleteFile_des
uFR_int_DesfireDeleteFile_2k3des
uFR_int_DesfireDeleteFile_3k3des
uFR_int_DesfireDeleteFile_aes_PK (alias for uFR_int_DesfireDeleteFile_PK)
uFR_int_DesfireDeleteFile_des_PK
uFR_int_DesfireDeleteFile_2k3des_PK
uFR_int_DesfireDeleteFile_3k3des_PK
uFR_SAM_DesfireDeleteFileAesAuth
uFR_SAM_DesfireDeleteFileDesAuth
uFR_SAM_DesfireDeleteFile2k3desAuth
uFR_SAM_DesfireDeleteFile3k3desAuth

Function description

Function deactivates a file within the currently selected application. Allocated memory blocks associated with deleted file not set free. Only format card function can delete the memory blocks. Is the application master key authentication is required, depending on the application master key settings.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireDeleteFile(uint8_t aes_key_nr,
                                     uint32_t aid,
                                     uint8_t file_id,
                                     uint16_t *card_status,
                                     uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteFile_PK(uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteFile_no_auth(uint32_t aid,
                                             uint8_t file_id,
                                             uint16_t *card_status,
                                             uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```
UFR_STATUS uFR_int_DesfireDeleteFile_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteFile_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteFile_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteFile_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteFile_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteFile_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
UFR_STATUS uFR_int_DesfireDeleteFile_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDeleteFile_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

***only uFR CS with SAM support**

```
UFR_STATUS uFR_SAM_DesfireDeleteFileAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDeleteFileDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDeleteFile2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDeleteFile3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key

des2k_key_ext **des3k_key_ext**	pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aid	ID of application that contains the file
file_id	ID of file that will be deleted (0 – 31)
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireReadStdDataFile (deprecated)
uFR_int_DesfireReadStdDataFile_PK (deprecated)
uFR_int_DesfireReadStdDataFile_no_auth
uFR_int_DesfireReadStdDataFile_aes (alias for uFR_int_DesfireReadStdDataFile)
uFR_int_DesfireReadStdDataFile_des
uFR_int_DesfireReadStdDataFile_2k3des
uFR_int_DesfireReadStdDataFile_3k3des
uFR_int_DesfireReadStdDataFile_aes_PK (alias for uFR_int_DesfireReadStdDataFile_PK)
uFR_int_DesfireReadStdDataFile_des_PK
uFR_int_DesfireReadStdDataFile_2k3des_PK
uFR_int_DesfireReadStdDataFile_3k3des_PK
uFR_SAM_DesfireReadStdDataFileAesAuth
uFR_SAM_DesfireReadStdDataFileDesAuth
uFR_SAM_DesfireReadStdDataFile2k3desAuth
uFR_SAM_DesfireReadStdDataFile3k3desAuth

Function description

Function allows to read data from Standard Data File, or from Backup Data File. Read command requires a preceding authentication either with the key specified for Read or Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireReadStdDataFile(uint8_t aes_key_nr,
                                          uint32_t aid,
                                          uint8_t aid_key_nr,
                                          uint8_t file_id,
                                          uint16_t offset,
                                          uint16_t data_length,
                                          uint8_t
communication_settings,
                                          uint8_t *data,
                                          uint16_t *card_status,
                                          uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadStdDataFile_PK(
                                          uint8_t *aes_key_ext,
                                          uint32_t aid,
                                          uint8_t aid_key_nr,
                                          uint8_t file_id,
                                          uint16_t offset,
                                          uint16_t data_length,
                                          uint8_t
communication_settings,
                                          uint8_t *data,
                                          uint16_t *card_status,
                                          uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadStdDataFile_no_auth(
                                          uint32_t aid,
                                          uint8_t aid_key_nr,
                                          uint8_t file_id,
                                          uint16_t offset,
                                          uint16_t data_length,
                                          uint8_t
communication_settings,
                                          uint8_t *data,
                                          uint16_t *card_status,
                                          uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```
UFR_STATUS uFR_int_DesfireReadStdDataFile_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadStdDataFile_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadStdDataFile_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadStdDataFile_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadStdDataFile_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadStdDataFile_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadStdDataFile_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadStdDataFile_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

***only uFR CS with SAM support**

```
UFR_STATUS uFR_SAM_DesfireReadStdDataFileAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadStdDataFileDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadStdDataFile2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadStdDataFile3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key

`aid`	ID of application that contains the file
`aid_key_nr`	key number into application
`file_id`	ID of file (0 – 31)
`offset`	start position for read operation within file
`data_length`	number of data to be read
`communication_settings`	value must be same as in file declaration
`data`	pointer to data array
`card_status`	pointer to card error variable
`exec_time`	function's execution time

uFR_int_DesfireWriteStdDataFile (deprecated)
uFR_int_DesfireWriteStdDataFile_PK (deprecated)
uFR_int_DesfireWriteStdDataFile_no_auth
uFR_int_DesfireWriteStdDataFile_aes (alias for uFR_int_DesfireWriteStdDataFile)
uFR_int_DesfireWriteStdDataFile_des
uFR_int_DesfireWriteStdDataFile_2k3des
uFR_int_DesfireWriteStdDataFile_3k3des
uFR_int_DesfireWriteStdDataFile_aes_PK (alias for uFR_int_DesfireWriteStdDataFile_PK)
uFR_int_DesfireWriteStdDataFile_des_PK
uFR_int_DesfireWriteStdDataFile_2k3des_PK
uFR_int_DesfireWriteStdDataFile_3k3des_PK
uFR_SAM_DesfireWriteStdDataFileAesAuth
uFR_SAM_DesfireWriteStdDataFileDesAuth
uFR_SAM_DesfireWriteStdDataFile2k3desAuth
uFR_SAM_DesfireWriteStdDataFile3k3desAuth

Function description
Function allow to write data to Standard Data File, or to Backup Data File. Write command requires a preceding authentication either with the key specified for Write or Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireWriteStdDataFile(
                                      uint8_t aes_key_nr,
                                      uint32_t aid,
                                      uint8_t aid_key_nr,
                                      uint8_t file_id,
                                      uint16_t offset,
                                      uint16_t data_length,
                                      uint8_t communication_settings,
                                      uint8_t *data,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteStdDataFile_PK(
                                      uint8_t *aes_key_ext,
                                      uint32_t aid,
                                      uint8_t aid_key_nr,
                                      uint8_t file_id,
                                      uint16_t offset,
                                      uint16_t data_length,
                                      uint8_t communication_settings,
                                      uint8_t *data,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteStdDataFile_no_auth(
                                      uint32_t aid,
                                      uint8_t aid_key_nr,
                                      uint8_t file_id,
                                      uint16_t offset,
                                      uint16_t data_length,
                                      uint8_t communication_settings,
                                      uint8_t *data,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
```

For uFR PLUS devices only. DES keys support.

```
UFR_STATUS uFR_int_DesfireWriteStdDataFile_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteStdDataFile_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteStdDataFile_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteStdDataFile_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteStdDataFile_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteStdDataFile_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteStdDataFile_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteStdDataFile_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

***only uFR CS with SAM support**

```
UFR_STATUS uFR_SAM_DesfireWriteStdDataFileAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireWriteStdDataFileDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireWriteStdDataFile2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireWriteStdDataFile3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key

`aid`	ID of application that contains the file
`aid_key_nr`	key number into application
`file_id`	ID of file (0 – 31)
`offset`	start position for read operation within file
`data_length`	number of data to be read
`communication_settings`	value must be same as in file declaration
`data`	pointer to data array
`card_status`	pointer to card error variable
`exec_time`	function's execution time

DES_to_AES_key_type

Function description

Function allow to change the card master key type from DES to AES. Factory setting for DESFIRE card master key is DES key type, and value is 0x0000000000000000. Because the reader uses AES keys, you must change the type key on AES. New AES key is 0x00000000000000000000000000000000.

Function declaration (C language)

```
UFR_STATUS DES_to_AES_key_type(void);
```

AES_to_DES_key_type

Function description

Function allow to change the card master key type from AES to DES. Set master AES key before use this function to 0x00000000000000000000000000000000. New DES key will be 0x0000000000000000 as in factory settings.

Function declaration (C language)

```
UFR_STATUS AES_to_DES_key_type(void);
```

uFR_int_DesfireCreateValueFile (deprecated)
uFR_int_DesfireCreateValueFile_PK (deprecated)
uFR_int_DesfireCreateValueFile_no_auth
uFR_int_DesfireCreateValueFile_aes (alias for uFR_int_DesfireCreateValueFile)
uFR_int_DesfireCreateValueFile_des
uFR_int_DesfireCreateValueFile_2k3des
uFR_int_DesfireCreateValueFile_3k3des
uFR_int_DesfireCreateValueFile_aes_PK (alias for uFR_int_DesfireCreateValueFile_PK)
uFR_int_DesfireCreateValueFile_des_PK
uFR_int_DesfireCreateValueFile_2k3des_PK
uFR_int_DesfireCreateValueFile_3k3des_PK
uFR_SAM_DesfireCreateValueFileAesAuth
uFR_SAM_DesfireCreateValueFileDesAuth
uFR_SAM_DesfireCreateValueFile2k3desAuth
uFR_SAM_DesfireCreateValueFile3k3desAuth

Function description

For uFR PLUS devices only.

Function allows to create file for the storage and manipulation of 32 bit signed integer values within existing application on the card. Maximal number of files into application is 32. The file will be created in the currently selected application. Is the application master key authentication is required, depending on the application master key settings.

Communication settings define communication mode between reader and card. The communication modes are:

- plain communication communication settings value is 0x00
- plain communication secured by MACing communication settings value is 0x01
- fully enciphered communication communication settings value is 0x03

Access rights for read, write, read&write and changing, references certain key within application's keys (0 – 13). If value is 14, this means free access, independent of previous authentication. If value is 15, this means deny access (for example if write access is 15 then the file type is read only).

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireCreateValueFile(
                                      uint8_t aes_key_nr,
                                      uint32_t aid,
                                      uint8_t file_id,
                                      int32_t lower_limit,
                                      int32_t upper_limit,
                                      int32_t value,
                                      uint8_t limited_credit_enabled,
                                      uint8_t read_key_no,
                                      uint8_t write_key_no,
                                      uint8_t read_write_key_no,
                                      uint8_t change_key_no,
                                      uint8_t communication_settings,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateValueFile_PK(
                                      uint8_t *aes_key_ext,
                                      uint32_t aid,
                                      uint8_t file_id,
                                      uint8_t lower_limit,
                                      int32_t upper_limit,
                                      int32_t value,
                                      uint8_t limited_credit_enabled,
                                      uint8_t read_key_no,
                                      uint8_t write_key_no,
                                      uint8_t read_write_key_no,
                                      uint8_t change_key_no,
                                      uint8_t communication_settings,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateValueFile_no_auth(
                                      uint32_t aid,
                                      uint8_t file_id,
                                      int32_t lower_limit,
                                      int32_t upper_limit,
                                      int32_t value,
                                      uint8_t limited_credit_enabled,
                                      uint8_t read_key_no,
                                      uint8_t write_key_no,
                                      uint8_t read_write_key_no,
                                      uint8_t change_key_no,
                                      uint8_t communication_settings,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateValueFile_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        int32_t lower_limit,
                                        int32_t upper_limit,
                                        int32_t value,
                                        uint8_t limited_credit_enabled,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateValueFile_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        int32_t lower_limit,
                                        int32_t upper_limit,
                                        int32_t value,
                                        uint8_t limited_credit_enabled,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateValueFile_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        int32_t lower_limit,
                                        int32_t upper_limit,
                                        int32_t value,
                                        uint8_t limited_credit_enabled,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateValueFile_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        int32_t lower_limit,
                                        int32_t upper_limit,
                                        int32_t value,
                                        uint8_t limited_credit_enabled,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateValueFile_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        int32_t lower_limit,
                                        int32_t upper_limit,
                                        int32_t value,
                                        uint8_t limited_credit_enabled,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateValueFile_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        int32_t lower_limit,
                                        int32_t upper_limit,
                                        int32_t value,
                                        uint8_t limited_credit_enabled,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateValueFile_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        int32_t lower_limit,
                                        int32_t upper_limit,
                                        int32_t value,
                                        uint8_t limited_credit_enabled,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
UFR_STATUS uFR_int_DesfireCreateValueFile_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        int32_t lower_limit,
                                        int32_t upper_limit,
                                        int32_t value,
                                        uint8_t limited_credit_enabled,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

***only uFR CS with SAM support**

```
UFR_STATUS uFR_SAM_DesfireCreateValueFileAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        int32_t lower_limit,
                                        int32_t upper_limit,
                                        int32_t value,
                                        uint8_t limited_credit_enabled,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateValueFileDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        int32_t lower_limit,
                                        int32_t upper_limit,
                                        int32_t value,
                                        uint8_t limited_credit_enabled,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateValueFile2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        int32_t lower_limit,
                                        int32_t upper_limit,
                                        int32_t value,
                                        uint8_t limited_credit_enabled,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateValueFile3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        int32_t lower_limit,
                                        int32_t upper_limit,
                                        int32_t value,
                                        uint8_t limited_credit_enabled,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aid	ID of application that contains the file
file_id	ID of file that will be created (0 – 31)
lower_limit	lower limit which is valid for this file

upper_limit	upper limit which is valid for this file
value	initial value of the value file
limited_credit_enabled	bit 0 – limited credit enabled (1 – yes, 0 – no) bit 1 – free get value (1 – yes, 0 – no)
read_key_no	key for get and debit value
write_key_no	key for get, debit and limited credit value
read_write_key_no	for get, debit, limited credit and credit value
change_key_no	key for changing this setting
communication_settings	variable that contains communication settings
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireReadValueFile (deprecated)
uFR_int_DesfireReadValueFile_PK (deprecated)
uFR_int_DesfireReadValueFile_no_auth
uFR_int_DesfireReadValueFile_aes (alias for uFR_int_DesfireReadValueFile)
uFR_int_DesfireReadValueFile_des
uFR_int_DesfireReadValueFile_2k3des
uFR_int_DesfireReadValueFile_3k3des
uFR_int_DesfireReadValueFile_aes_PK (alias for uFR_int_DesfireReadValueFile_PK)
uFR_int_DesfireReadValueFile_des_PK
uFR_int_DesfireReadValueFile_2k3des_PK
uFR_int_DesfireReadValueFile_3k3des_PK
uFR_SAM_DesfireReadValueFileAesAuth
uFR_SAM_DesfireReadValueFileDesAuth
uFR_SAM_DesfireReadValueFile2k3desAuth
uFR_SAM_DesfireReadValueFile3k3desAuth

Function description

For uFR PLUS devices only.

Function allow to read value from value files. Read command requires a preceding authentication either with the key specified for Read or Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireReadValueFile(
                                      uint8_t aes_key_nr,
                                      uint32_t aid,
                                      uint8_t aid_key_nr,
                                      uint8_t communication_settings,
                                      int32_t *value,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadValueFile_PK(
                                      uint8_t *aes_key_ext,
                                      uint32_t aid,
                                      uint8_t aid_key_nr,
                                      uint8_t communication_settings,
                                      int32_t *value,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadValueFile_no_auth(
                                      uint32_t aid,
                                      uint8_t aid_key_nr,
                                      uint8_t communication_settings,
                                      int32_t *value,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadValueFile_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        int32_t *value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadValueFile_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        int32_t *value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadValueFile_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        int32_t *value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadValueFile_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        int32_t *value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadValueFile_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        int32_t *value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadValueFile_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        int32_t *value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadValueFile_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        int32_t *value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadValueFile_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        int32_t *value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

***only uFR CS with SAM support**

```
UFR_STATUS uFR_SAM_DesfireReadValueFileAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        int32_t *value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadValueFileDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        int32_t *value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadValueFile2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        int32_t *value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadValueFile3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        int32_t *value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key

aid	ID of application that contains the file
aid_key_nr	key number into application
communication_settings	value must be the same as in file declaration
value	pointer to value variable
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireIncreaseValueFile (deprecated)
uFR_int_DesfireIncreaseValueFile_PK (deprecated)
uFR_int_DesfireIncreaseValueFile_no_auth
uFR_int_DesfireIncreaseValueFile_aes (alias for uFR_int_DesfireIncreaseValueFile)
uFR_int_DesfireIncreaseValueFile_des
uFR_int_DesfireIncreaseValueFile_2k3des
uFR_int_DesfireIncreaseValueFile_3k3des
uFR_int_DesfireIncreaseValueFile_aes_PK (alias for uFR_int_DesfireIncreaseValueFile_PK)
uFR_int_DesfireIncreaseValueFile_des_PK
uFR_int_DesfireIncreaseValueFile_2k3des_PK
uFR_int_DesfireIncreaseValueFile_3k3des_PK
uFR_SAM_DesfireIncreaseValueFileAesAuth
uFR_SAM_DesfireIncreaseValueFileDesAuth
uFR_SAM_DesfireIncreaseValueFile2k3desAuth
uFR_SAM_DesfireIncreaseValueFile3k3desAuth
uFR_int_DesfireIncreaseValueFile_TransMac_aes
uFR_int_DesfireIncreaseValueFile_TransMac_des
uFR_int_DesfireIncreaseValueFile_TransMac_2k3des
uFR_int_DesfireIncreaseValueFile_TransMac_3k3des
uFR_int_DesfireIncreaseValueFile_TransMac_aes_PK
uFR_int_DesfireIncreaseValueFile_TransMac_des_PK
uFR_int_DesfireIncreaseValueFile_TransMac_2k3des_PK
uFR_int_DesfireIncreaseValueFile_TransMac_3k3des_PK
uFR_SAM_DesfireIncreaseValueFile_TransMac_AesAuth
uFR_SAM_DesfireIncreaseValueFile_TransMac_DesAuth
uFR_SAM_DesfireIncreaseValueFile_TransMac_2k3desAuth
uFR_SAM_DesfireIncreaseValueFile_TransMac_3k3desAuth

Function description
For uFR PLUS devices only.

Function allows to increase a value stored in a value files. Credit command requires a preceding authentication with the key specified for Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

NOTE: Transaction MAC file exist by factory default setting. For using this function, user must delete transaction MAC file first.

From library version 5.0.37 and firmware version 5.0.38, Transaction MAC operation supported for Desfire Light and Desfire EV2. To use these features, an Transaction MAC file must exist in the selected application. Function returns current Reader ID if they used, Previous Encrypted Reader ID, Transaction MAC counter, and Transaction MAC.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireIncreaseValueFile(
                                      uint8_t aes_key_nr,
                                      uint32_t aid,
                                      uint8_t aid_key_nr,
                                      uint8_t communication_settings,
                                      int32_t value,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_PK(
                                      uint8_t *aes_key_ext,
                                      uint32_t aid,
                                      uint8_t aid_key_nr,
                                      uint8_t communication_settings,
                                      int32_t value,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
FR_STATUS uFR_int_DesfireIncreaseValueFile_no_auth(
                                      uint32_t aid,
                                      uint8_t aid_key_nr,
                                      uint8_t communication_settings,
                                      int32_t value,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);

*only uFR CS with SAM support

UFR_STATUS uFR_SAM_DesfireIncreaseValueFileAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireIncreaseValueFileDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireIncreaseValueFile2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireIncreaseValueFile3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
*Transaction MAC support
```

```
UFR_STATUS uFR_int_DesfireIncreaseValueFile_TransMac_aes(
          uint8_t aes_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_TransMac_des(
          uint8_t des_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_TransMac_2k3des(
          uint8_t des2k_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_TransMac_3k3des(
          uint8_t des3k_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_TransMac_aes_PK(
          uint8_t *aes_key_ext, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_TransMac_des_PK(
          uint8_t *des_key_ext, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_TransMac_2k3des_PK(
          uint8_t *des2k_key_ext, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireIncreaseValueFile_TransMac_3k3des_PK(
          uint8_t *des3k_key_ext, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireIncreaseValueFile_TransMac_AesAuth(
          uint8_t aes_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireIncreaseValueFile_TransMac_DesAuth(
          uint8_t des_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireIncreaseValueFile_TransMac_2k3desAuth(
          uint8_t des2k_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireIncreaseValueFile_TransMac_3k3desAuth(
          uint8_t des3k_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
```

Parameters

aes_key_nr	ordinal number of AES key in the reader
des_key_nr	ordinal number of DES key in the reader
des2k_key_nr	ordinal number of 2K3DES key in the reader
des3k_key_nr	ordinal number of 3K3DES key in the reader

aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aid	ID of application that contains the file
aid_key_nr	key number into application
communication_settings	value must be the same as in file declaration
value	value (must be a positive number)
card_status	pointer to card error variable
exec_time	function's execution time
use_reader_id	0 - Reader ID is not used, 1- Reader ID is used
reader_id	pointer to 16 bytes array containing the Reader ID
prev_enc_reader_id	pointer to 16 bytes array containing the Previous Encrypted Reader ID
trans_mac_cnt	pointer to value of Transaction MAC counter
trans_mac_value	pointer to 8 bytes array containing Transaction MAC

uFR_int_DesfireDecreaseValueFile (deprecated)
uFR_int_DesfireDecreaseValueFile_PK (deprecated)
uFR_int_DesfireDecreaseValueFile_no_auth
uFR_int_DesfireDecreaseValueFile_aes (alias for uFR_int_DesfireDecreaseValueFile)
uFR_int_DesfireDecreaseValueFile_des
uFR_int_DesfireDecreaseValueFile_2k3des
uFR_int_DesfireDecreaseValueFile_3k3des
uFR_int_DesfireDecreaseValueFile_aes_PK (alias for uFR_int_DesfireDecreaseValueFile_PK)
uFR_int_DesfireDecreaseValueFile_des_PK
uFR_int_DesfireDecreaseValueFile_2k3des_PK
uFR_int_DesfireDecreaseValueFile_3k3des_PK
uFR_SAM_DesfireDecreaseValueFileAesAuth
uFR_SAM_DesfireDecreaseValueFileDesAuth
uFR_SAM_DesfireDecreaseValueFile2k3desAuth
uFR_SAM_DesfireDecreaseValueFile3k3desAuth
uFR_int_DesfireDecreaseValueFile_TransMac_aes
uFR_int_DesfireDecreaseValueFile_TransMac_des
uFR_int_DesfireDecreaseValueFile_TransMac_2k3des
uFR_int_DesfireDecreaseValueFile_TransMac_3k3des
uFR_int_DesfireDecreaseValueFile_TransMac_aes_PK
uFR_int_DesfireDecreaseValueFile_TransMac_des_PK
uFR_int_DesfireDecreaseValueFile_TransMac_2k3des_PK
uFR_int_DesfireDecreaseValueFile_TransMac_3k3des_PK
uFR_SAM_DesfireDecreaseValueFile_TransMac_AesAuth
uFR_SAM_DesfireDecreaseValueFile_TransMac_DesAuth
uFR_SAM_DesfireDecreaseValueFile_TransMac_2k3desAuth
uFR_SAM_DesfireDecreaseValueFile_TransMac_3k3desAuth

Function description
For uFR PLUS devices only

Function allows to decrease value from value files. Debit command requires a preceding authentication with on of the keys specified for Read, Write or Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

NOTE: Transaction MAC file exist by factory default setting. For using this function, user must delete transaction MAC file first.

From library version 5.0.37 and firmware version 5.0.38, Transaction MAC operation supported for Desfire Light and Desfire EV2. To use these features, an Transaction MAC file must exist in the selected application. Function returns current Reader ID if they used, Previous Encrypted Reader ID, Transaction MAC counter, and Transaction MAC.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireDecreaseValueFile(
                                      uint8_t aes_key_nr,
                                      uint32_t aid,
                                      uint8_t aid_key_nr,
                                      uint8_t communication_settings,
                                      int32_t value,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_PK(
                                      uint8_t *aes_key_ext,
                                      uint32_t aid,
                                      uint8_t aid_key_nr,
                                      uint8_t communication_settings,
                                      int32_t value,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_no_auth(
                                      uint32_t aid,
                                      uint8_t aid_key_nr,
                                      uint8_t communication_settings,
                                      int32_t *value,
                                      uint16_t *card_status,
                                      uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_3k3des(
                                        uint8_t des3_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

***only uFR CS with SAM support**

```
UFR_STATUS uFR_SAM_DesfireDecreaseValueFileAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDecreaseValueFileDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDecreaseValueFile2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireDecreaseValueFile3k3desAuth(
                                        uint8_t des3_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint8_t communication_settings,
                                        uint32_t value,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
*Transaction MAC support
```

```
UFR_STATUS uFR_int_DesfireDecreaseValueFile_TransMac_aes(
          uint8_t aes_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_TransMac_des(
          uint8_t des_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_TransMac_2k3des(
          uint8_t des2k_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_TransMac_3k3des(
          uint8_t des3k_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_TransMac_aes_PK(
          uint8_t *aes_key_ext, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_TransMac_des_PK(
          uint8_t *des_key_ext, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_TransMac_2k3des_PK(
          uint8_t *des2k_key_ext, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireDecreaseValueFile_TransMac_3k3des_PK(
          uint8_t *des3k_key_ext, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireDecreaseValueFile_TransMac_AesAuth(
          uint8_t aes_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireDecreaseValueFile_TransMac_DesAuth(
          uint8_t des_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireDecreaseValueFile_TransMac_2k3desAuth(
          uint8_t des2k_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireDecreaseValueFile_TransMac_3k3desAuth(
          uint8_t des3k_key_nr, uint32_t aid, uint8_t aid_key_nr,
          uint8_t file_id, uint8_t communication_settings,
          uint32_t value, uint16_t *card_status, uint16_t *exec_time,
          uint8_t use_reader_id, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint32_t *trans_mac_cnt,
          uint8_t *trans_mac_value);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key

aid	ID of application that contains the file
aid_key_nr	key number into application
communication_settings	value must be the same as in file declaration
value	value (must be a positive number)
card_status	pointer to card error variable
exec_time	function's execution time
use_reader_id	0 - Reader ID is not used, 1- Reader ID is used
reader_id	pointer to 16 bytes array containing the Reader ID
prev_enc_reader_id	pointer to 16 bytes array containing the Previous Encrypted Reader ID
trans_mac_cnt	pointer to value of Transaction MAC counter
trans_mac_value	pointer to 8 bytes array containing Transaction MAC

uFR_int_DesfireGetApplicationIds (deprecated)
uFR_int_DesfireGetApplicationIds_PK (deprecated)
uFR_int_DesfireGetApplicationIds_no_auth
uFR_int_DesfireGetApplicationIds_aes (alias for uFR_int_DesfireGetApplicationIds)
uFR_int_DesfireGetApplicationIds_des
uFR_int_DesfireGetApplicationIds_2k3des
uFR_int_DesfireGetApplicationIds_3k3des
uFR_int_DesfireGetApplicationIds_aes_PK (alias for uFR_int_DesfireGetApplicationIds_PK)
uFR_int_DesfireGetApplicationIds_des_PK
uFR_int_DesfireGetApplicationIds_2k3des_PK
uFR_int_DesfireGetApplicationIds_3k3des_PK
uFR_SAM_DesfireGetApplicationIdsAesAuth
uFR_SAM_DesfireGetApplicationIdsDesAuth
uFR_SAM_DesfireGetApplicationIds2k3desAuth
uFR_SAM_DesfireGetApplicationIds3k3desAuth

Function description
For uFR PLUS devices only

Function returns the Application Identifiers for all active applications on a card.

Function declaration (C language)

```
UFR_STATUS DL_API uFR_int_DesfireGetApplicationIds(
                              uint8_t aes_key_nr,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireGetApplicationIds_PK(
                              uint8_t *aes_key_ext,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetApplicationIds_no_auth(
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetApplicationIds_aes(
                              uint8_t aes_key_nr,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetApplicationIds_des(
                              uint8_t des_key_nr,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetApplicationIds_2k3des(
                              uint8_t des2k_key_nr,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetApplicationIds_3k3des(
                              uint8_t des3k_key_nr,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetApplicationIds_aes_PK(
                              uint8_t *aes_key_ext,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetApplicationIds_des_PK(
                              uint8_t *des_key_ext,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetApplicationIds_2k3des_PK(
                              uint8_t *des2k_key_ext,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireGetApplicationIds_3k3des_PK(
                              uint8_t *des3k_key_ext,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
```

***only uFR CS with SAM support**

```
UFR_STATUS uFR_SAM_DesfireGetApplicationIdsAesAuth(
                              uint8_t aes_key_nr,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireGetApplicationIdsDesAuth(
                              uint8_t des_key_nr,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireGetApplicationIds2k3desAuth(
                              uint8_t des2k_key_nr,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireGetApplicationIds3k3desAuth(
                              uint8_t des3k_key_nr,
                              uint32_t *application_ids,
                              uint8_t *number_of_aplication_ids,
                              uint16_t *card_status,
                              uint16_t *exec_time);
```

Parameters

aes_key_nr	ordinal number of AES key in the reader
des_key_nr	ordinal number of DES key in the reader
des2k_key_nr	ordinal number of 2K3DES key in the reader

des3k_key_nr	ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aplication_ids	array of application identifiers
number_of_application_ids	number of application identifiers
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireCreateLinearRecordFile_aes
uFR_int_DesfireCreateLinearRecordFile_des
uFR_int_DesfireCreateLinearRecordFile_2k3des
uFR_int_DesfireCreateLinearRecordFile_3k3des
uFR_int_DesfireCreateLinearRecordFile_aes_PK
uFR_int_DesfireCreateLinearRecordFile_des_PK
uFR_int_DesfireCreateLinearRecordFile_2k3des_PK
uFR_int_DesfireCreateLinearRecordFile_3k3des_PK
uFR_int_DesfireCreateLinearRecordFile_no_auth
uFR_SAM_DesfireCreateLinearRecordFileAesAuth
uFR_SAM_DesfireCreateLinearRecordFileDesAuth
uFR_SAM_DesfireCreateLinearRecordFile2k3desAuth
uFR_SAM_DesfireCreateLinearRecordFile3k3desAuth

For uFR PLUS devices only.

Function description

Function allows to create file for multiple storage of structural data, within an existing application. Once the file filled completely with data records, further writing to file is not possible unless it is cleared.

Maximal number of files into application is 32. The file will be created in the currently selected application. Is the application master key authentication is required, depend on the application master key settings.

Communication settings define communication mode between reader and card. The communication modes are:

- plain communication	communication settings value is 0x00

- plain communication secured by MACing	communication settings value is 0x01

- fully enciphered communication communication settings value is 0x03

Access rights for read, write, read&write and changing, references certain key within application's keys (0 – 13). If value is 14, this means free access, independent of previous authentication. If value is 15, this means deny access (for example if write access is 15 then the file type is read only).

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid, uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid, uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid, uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid, uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateLinearRecordFile_no_auth(
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

***only uFR CS with SAM support**

```
UFR_STATUS uFR_SAM_DesfireCreateLinearRecordFileAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid, uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateLinearRecordFileDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid, uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateLinearRecordFile2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid, uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateLinearRecordFile3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid, uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key

des2k_key_ext **des3k_key_ext**	pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aid	ID of application that contains the file
file_id	ID of file that will be created (0 – 31)
record_size	size of record in bytes
max_rec_no	maximal number of records in file
read_key_no	key for reading
write_key_no	key for writing
read_write_key_no	key for reading and writing
change_key_no	key for changing this setting
communication_settings	variable that contains communication settings
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireCreateCyclicRecordFile_aes
uFR_int_DesfireCreateCyclicRecordFile_des
uFR_int_DesfireCreateCyclicRecordFile_2k3des
uFR_int_DesfireCreateCyclicRecordFile_3k3des
uFR_int_DesfireCreateCyclicRecordFile_aes_PK
uFR_int_DesfireCreateCyclicRecordFile_des_PK
uFR_int_DesfireCreateCyclicRecordFile_2k3des_PK
uFR_int_DesfireCreateCyclicRecordFile_3k3des_PK
uFR_int_DesfireCreateCyclicRecordFile_no_auth
uFR_SAM_DesfireCreateCyclicRecordFileAesAuth
uFR_SAM_DesfireCreateCyclicRecordFileDesAuth
uFR_SAM_DesfireCreateCyclicRecordFile2k3desAuth
uFR_SAM_DesfireCreateCyclicRecordFile3k3desAuth

For uFR PLUS devices only.

Function description

Function allows to create file for multiple storage of structural data, within an existing application. Once the file filled completely with data records, the card automatically overwrites the oldest record with latest written one.

Maximal number of files into application is 32. The file will be created in the currently selected application. Is the application master key authentication is required, depend on the application master key settings.

Communication settings define communication mode between reader and card. The communication modes are:

- plain communication   communication settings value is 0x00

- plain communication secured by MACing   communication settings value is 0x01

- fully enciphered communication   communication settings value is 0x03

Access rights for read, write, read&write and changing, references certain key within application's keys (0 – 13). If value is 14, this means free access, independent of previous authentication. If value is 15, this means deny access (for example if write access is 15 then the file type is read only).

Function declaration (C language)

```
UFR_STATUSuFR_int_DesfireCreateCyclicRecordFile_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireCreateCyclicRecordFile_no_auth(
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
*only uFR CS with SAM support
UFR_STATUS uFR_SAM_DesfireCreateCyclicRecordFileAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateCyclicRecordFileDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateCyclicRecordFile2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireCreateCyclicRecordFile3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        uint32_t record_size,
                                        uint32_t max_rec_no,
                                        uint8_t read_key_no,
                                        uint8_t write_key_no,
                                        uint8_t read_write_key_no,
                                        uint8_t change_key_no,
                                        uint8_t communication_settings,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aid	ID of application that contains the file
file_id	ID of file that will be created (0 – 31)
record_size	size of record in bytes
max_rec_no	maximal number of records in file
read_key_no	key for reading

`write_key_no`	key for writing
`read_write_key_no`	key for reading and writing
`change_key_no`	key for changing this setting
`communication_settings`	variable that contains communication settings
`card_status`	pointer to card error variable
`exec_time`	function's execution time

uFR_int_DesfireWriteRecord_aes
uFR_int_DesfireWriteRecord_des
uFR_int_DesfireWriteRecord_2k3des
uFR_int_DesfireWriteRecord_3k3des
uFR_int_DesfireWriteRecord_aes_PK
uFR_int_DesfireWriteRecord_des_PK
uFR_int_DesfireWriteRecord_2k3des_PK
uFR_int_DesfireWriteRecord_3k3des_PK
uFR_int_DesfireWriteRecord_no_auth
uFR_SAM_DesfireWriteRecordAesAuth
uFR_SAM_DesfireWriteRecordDesAuth
uFR_SAM_DesfireWriteRecord2k3desAuth
uFR_SAM_DesfireWriteRecord3k3desAuth
uFR_int_DesfireWriteRecord_TransMac_aes
uFR_int_DesfireWriteRecord_TransMac_des
uFR_int_DesfireWriteRecord_TransMac_2k3des
uFR_int_DesfireWriteRecord_TransMac_3k3des
uFR_int_DesfireWriteRecord_TransMac_aes_PK
uFR_int_DesfireWriteRecord_TransMac_des_PK
uFR_int_DesfireWriteRecord_TransMac_2k3des_PK
uFR_int_DesfireWriteRecord_TransMac_3k3des_PK
uFR_SAM_DesfireWriteRecord_TransMac_AesAuth
uFR_SAM_DesfireWriteRecord_TransMac_DesAuth
uFR_SAM_DesfireWriteRecord_TransMac_2k3desAuth
uFR_SAM_DesfireWriteRecord_TransMac_3k3desAuth

For uFR PLUS devices only.

Function description

Function allows to write data to a record in a Linear Record File or Cyclic Record File. Write command requires a preceding authentication either with the key specified for Write or Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

NOTE: Transaction MAC file exist by factory default setting. For using this function, user must delete transaction MAC file first.

From library version 5.0.37 and firmware version 5.0.38, Transaction MAC operation supported for Desfire Light and Desfire EV2. To use these features, an Transaction MAC file must exist in the selected application. Function returns current Reader ID if they used, Previous Encrypted Reader ID, Transaction MAC counter, and Transaction MAC.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireWriteRecord_aes(uint8_t aes_key_nr,
                                          uint32_t aid,
                                          uint8_t aid_key_nr,
                                          uint8_t file_id,
                                          uint16_t offset,
                                          uint16_t data_length,
                                          uint8_t communication_settings,
                                          uint8_t *data,
                                          uint16_t *card_status,
                                          uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteRecord_des(
                                          uint8_t des_key_nr,
                                          uint32_t aid,
                                          uint8_t aid_key_nr,
                                          uint8_t file_id,
                                          uint16_t offset,
                                          uint16_t data_length,
                                          uint8_t communication_settings,
                                          uint8_t *data,
                                          uint16_t *card_status,
                                          uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteRecord_2k3des(
                                          uint8_t des2k_key_nr,
                                          uint32_t aid,
                                          uint8_t aid_key_nr,
                                          uint8_t file_id,
                                          uint16_t offset,
                                          uint16_t data_length,
                                          uint8_t communication_settings,
                                          uint8_t *data,
                                          uint16_t *card_status,
                                          uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteRecord_3k3des(
                                          uint8_t des3k_key_nr,
                                          uint32_t aid,
                                          uint8_t aid_key_nr,
                                          uint8_t file_id,
                                          uint16_t offset,
                                          uint16_t data_length,
                                          uint8_t communication_settings,
                                          uint8_t *data,
                                          uint16_t *card_status,
                                          uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireWriteRecord_aes_PK(
                                          IN uint8_t *aes_key_ext,
                                          uint32_t aid,
                                          uint8_t aid_key_nr,
                                          uint8_t file_id,
                                          uint16_t offset,
                                          uint16_t data_length,
                                          uint8_t communication_settings,
                                          uint8_t *data,
                                          uint16_t *card_status,
                                          uint16_t *exec_time);
  UFR_STATUS uFR_int_DesfireWriteRecord_des_PK(
                                          uint8_t *des_key_ext,
                                          uint32_t aid,
                                          uint8_t aid_key_nr,
                                          uint8_t file_id,
                                          uint16_t offset,
                                          uint16_t data_length,
                                          uint8_t communication_settings,
                                          uint8_t *data,
                                          uint16_t *card_status,
                                          uint16_t *exec_time);
  UFR_STATUS uFR_int_DesfireWriteRecord_2k3des_PK(
                                          uint8_t *des2k_key_ext,
                                          uint32_t aid,
                                          uint8_t aid_key_nr,
                                          uint8_t file_id,
                                          uint16_t offset,
                                          uint16_t data_length,
                                          uint8_t communication_settings,
                                          uint8_t *data,
                                          uint16_t *card_status,
                                          uint16_t *exec_time);
  UFR_STATUS uFR_int_DesfireWriteRecord_3k3des_PK(
                                          uint8_t *des3k_key_ext,
                                          uint32_t aid,
                                          uint8_t aid_key_nr,
                                          uint8_t file_id,
                                          uint16_t offset,
                                          uint16_t data_length,
                                          uint8_t communication_settings,
                                          uint8_t *data,
                                          uint16_t *card_status,
                                          uint16_t *exec_time);
  UFR_STATUS uFR_int_DesfireWriteRecord_no_auth(
                                          uint32_t aid,
                                          uint8_t aid_key_nr,
                                          uint8_t file_id,
                                          uint16_t offset,
                                          uint16_t data_length,
                                          uint8_t communication_settings,
                                          uint8_t *data,
                                          uint16_t *card_status,
                                          uint16_t *exec_time);

  *only uFR CS with SAM support
```

```
UFR_STATUS uFR_SAM_DesfireWriteRecordAesAuth(uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireWriteRecordDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireWriteRecord2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireWriteRecord3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t data_length,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
*Transaction MAC support
UFR_STATUS uFR_int_DesfireWriteRecord_TransMac_aes(
               uint8_t aes_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id, uint16_t offset, uint16_t data_length,
               uint8_t communication_settings, uint8_t *data,
                    uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireWriteRecord_TransMac_des(
               uint8_t des_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id, uint16_t offset, uint16_t data_length,
               uint8_t communication_settings, uint8_t *data,
                    uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireWriteRecord_TransMac_2k3des(
               uint8_t des2k_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id, uint16_t offset, uint16_t data_length,
               uint8_t communication_settings, uint8_t *data,
                    uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireWriteRecord_TransMac_3k3des(
               uint8_t des3k_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id, uint16_t offset, uint16_t data_length,
               uint8_t communication_settings, uint8_t *data,
                    uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireWriteRecord_TransMac_aes_PK(
               uint8_t *aes_key_ext, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id, uint16_t offset, uint16_t data_length,
               uint8_t communication_settings, uint8_t *data,
                    uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireWriteRecord_TransMac_des_PK(
               uint8_t *des_key_ext, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id, uint16_t offset, uint16_t data_length,
               uint8_t communication_settings, uint8_t *data,
                    uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireWriteRecord_TransMac_2k3des_PK(
               uint8_t *des2k_key_ext, uint32_t aid,
               uint8_t aid_key_nr, uint8_t file_id, uint16_t offset,
               uint16_t data_length, uint8_t communication_settings,
               uint8_t *data, uint16_t *card_status,
               uint16_t *exec_time, uint8_t use_reader_id,
               uint8_t *reader_id,uint8_t *prev_enc_reader_id,
                    uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
```

```
UFR_STATUS uFR_int_DesfireWriteRecord_TransMac_3k3des_PK(
               uint8_t *des3k_key_ext, uint32_t aid,
               uint8_t aid_key_nr, uint8_t file_id, uint16_t offset,
               uint16_t data_length, uint8_t communication_settings,
               uint8_t *data, uint16_t *card_status,
               uint16_t *exec_time, uint8_t use_reader_id,
               uint8_t *reader_id, uint8_t *prev_enc_reader_id,
                    uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireWriteRecord_TransMac_AesAuth(
               uint8_t aes_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id, uint16_t offset, uint16_t data_length,
               uint8_t communication_settings, uint8_t *data,
                    uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireWriteRecord_TransMac_DesAuth(
               uint8_t des_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id, uint16_t offset, uint16_t data_length,
               uint8_t communication_settings, uint8_t *data,
                    uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireWriteRecord_TransMac_2k3desAuth(
               uint8_t des2k_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id, uint16_t offset, uint16_t data_length,
               uint8_t communication_settings, uint8_t *data,
                    uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireWriteRecord_TransMac_3k3desAuth(
               uint8_t des3k_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id, uint16_t offset, uint16_t data_length,
               uint8_t communication_settings, uint8_t *data,
                    uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader

aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aid	ID of application that contains the file
aid_key_nr	key number into application
file_id	ID of file (0 – 31)
offset	start position for read operation within file
data_length	number of data to be read
communication_settings	value must be the same as in file declaration
data	pointer to data array
card_status	pointer to card error variable
exec_time	function's execution time
use_reader_id	0 - Reader ID is not used, 1- Reader ID is used
reader_id	pointer to 16 bytes array containing the Reader ID
prev_enc_reader_id	pointer to 16 bytes array containing the Previous Encrypted Reader ID
trans_mac_cnt	pointer to value of Transaction MAC counter
trans_mac_value	pointer to 8 bytes array containing Transaction MAC

uFR_int_DesfireReadRecords_aes
uFR_int_DesfireReadRecords_des
uFR_int_DesfireReadRecords_2k3des
uFR_int_DesfireReadRecords_3k3des
uFR_int_DesfireReadRecords_aes_PK
uFR_int_DesfireReadRecords_des_PK
uFR_int_DesfireReadRecords_2k3des_PK
uFR_int_DesfireReadRecords_3k3des_PK
uFR_int_DesfireReadRecords_no_auth
uFR_SAM_DesfireReadRecordsAesAuth
uFR_SAM_DesfireReadRecordsDesAuth
uFR_SAM_DesfireReadRecords2k3desAuth
uFR_SAM_DesfireReadRecords3k3desAuth

For uFR PLUS devices only.

Function description

Function allows to read data from a record in a Linear Record File or Cyclic Record File. Read command requires a preceding authentication either with the key specified for Read or Read&Write access.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireReadRecords_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t number_of_records,
                                        uint16_t record_size,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadRecords_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t number_of_records,
                                        uint16_t record_size,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

```
UFR_STATUS uFR_int_DesfireReadRecords_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t number_of_records,
                                        uint16_t record_size,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadRecords_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t number_of_records,
                                        uint16_t record_size,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadRecords_aes_PK(
                                        uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t number_of_records,
                                        uint16_t record_size,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadRecords_des_PK(
                                        uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t number_of_records,
                                        uint16_t record_size,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadRecords_2k3des_PK(
                                        uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t number_of_records,
                                        uint16_t record_size,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadRecords_3k3des_PK(
                                        uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t number_of_records,
                                        uint16_t record_size,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_int_DesfireReadRecords_no_auth(
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t number_of_records,
                                        uint16_t record_size,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        VAR uint16_t *exec_time);
```

```
*only uFR CS with SAM support
UFR_STATUS uFR_SAM_DesfireReadRecordsAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t number_of_records,
                                        uint16_t record_size,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadRecordsDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t number_of_records,
                                        uint16_t record_size,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadRecords2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t number_of_records,
                                        uint16_t record_size,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
UFR_STATUS uFR_SAM_DesfireReadRecords3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        uint16_t offset,
                                        uint16_t number_of_records,
                                        uint16_t record_size,
                                        uint8_t communication_settings,
                                        uint8_t *data,
                                        uint16_t *card_status,
                                        uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aid	ID of application that contains the file

aid_key_nr	key number into application
file_id	ID of file (0 – 31)
offset	start position for read operation within file
number_of_records	number of records to be read
record_size	size of record in bytes
communication_settings	value must be the same as in file declaration
data	pointer to data array
card_status	pointer to card error variable
exec_time	function's execution time

uFR_int_DesfireClearRecordFile_aes
uFR_int_DesfireClearRecordFile_des
uFR_int_DesfireClearRecordFile_2k3des
uFR_int_DesfireClearRecordFile_3k3des
uFR_int_DesfireClearRecordFile_aes_PK
uFR_int_DesfireClearRecordFile_des_PK
uFR_int_DesfireClearRecordFile_2k3des_PK
uFR_int_DesfireClearRecordFile_3k3des_PK
uFR_int_DesfireClearRecordFile_no_auth
uFR_SAM_DesfireClearRecordFileAesAuth
uFR_SAM_DesfireClearRecordFileDesAuth
uFR_SAM_DesfireClearRecordFile2k3desAuth
uFR_SAM_DesfireClearRecordFile3k3desAuth
uFR_int_DesfireClearRecordFile_aes_2
uFR_int_DesfireClearRecordFile_des_2
uFR_int_DesfireClearRecordFile_2k3des_2
uFR_int_DesfireClearRecordFile_3k3des_2
uFR_int_DesfireClearRecordFile_aes_PK_2
uFR_int_DesfireClearRecordFile_des_PK_2
uFR_int_DesfireClearRecordFile_2k3des_PK_2
uFR_int_DesfireClearRecordFile_3k3des_PK_2
uFR_SAM_DesfireClearRecordFileAesAuth_2
uFR_SAM_DesfireClearRecordFileDesAuth_2
uFR_SAM_DesfireClearRecordFile2k3desAuth_2
uFR_SAM_DesfireClearRecordFile3k3desAuth_2
uFR_int_DesfireClearRecordFile_TransMac_aes
uFR_int_DesfireClearRecordFile_TransMac_des
uFR_int_DesfireClearRecordFile_TransMac_2k3des
uFR_int_DesfireClearRecordFile_TransMac_3k3des
uFR_int_DesfireClearRecordFile_TransMac_aes_PK
uFR_int_DesfireClearRecordFile_TransMac_des_PK
uFR_int_DesfireClearRecordFile_TransMac_2k3des_PK
uFR_int_DesfireClearRecordFile_TransMac_3k3des_PK
uFR_SAM_DesfireClearRecordFile_TransMac_AesAuth
uFR_SAM_DesfireClearRecordFile_TransMac_DesAuth
uFR_SAM_DesfireClearRecordFile_TransMac_2k3desAuth
uFR_SAM_DesfireClearRecordFile_TransMac_3k3desAuth

For uFR PLUS devices only.

Function description

Function allows to reset a Linear Record File or Cyclic Record file to the empty state. Clear command requires a preceding authentication with the key specified for Read&Write access.

Bug fix from library version 5.0.29. The aid key number was omitted in function parameters, so it was used application master key number 0 for Read&Write access. For compatibility reasons old functions were retained. New function names have the "_2" suffix.

From library version 5.0.29 and firmware version 5.0.32, Desfire Light supported.

NOTE: Transaction MAC file exist by factory default setting. For using this function, user must delete transaction MAC file first.

From library version 5.0.37 and firmware version 5.0.38, Transaction MAC operation supported for Desfire Light and Desfire EV2. To use these features, an Transaction MAC file must exist in the selected application. Function returns current Reader ID if they used, Previous Encrypted Reader ID, Transaction MAC counter, and Transaction MAC.

Function declaration (C language)

```
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_aes(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_des(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_2k3des(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_3k3des(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_aes_PK(
                                        IN uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_des_PK(
                                        IN uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_2k3des_PK(
                                        IN uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
```

```
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_3k3des_PK(
                                        IN uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_no_auth(
                                        uint32_t aid,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
```

```
*only uFR CS with SAM support
```

```
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFileAesAuth(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFileDesAuth(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFile2k3desAuth(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFile3k3desAuth(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
*From library version 5.0.29.
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_aes_2(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_des_2(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_2k3des_2(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_3k3des_2(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFileAesAuth_2(
                                        uint8_t aes_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFile3k3desAuth_2(
                                        uint8_t des3k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFileDesAuth_2(
                                        uint8_t des_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireClearRecordFile2k3desAuth_2(
                                        uint8_t des2k_key_nr,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_aes_PK_2(
                                        IN uint8_t *aes_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_des_PK_2(
                                        IN uint8_t *des_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_2k3des_PK_2(
                                        IN uint8_t *des2k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireClearRecordFile_3k3des_PK_2(
                                        IN uint8_t *des3k_key_ext,
                                        uint32_t aid,
                                        uint8_t aid_key_nr,
                                        uint8_t file_id,
                                        VAR uint16_t *card_status,
                                        VAR uint16_t *exec_time);
*Transaction MAC support
UFR_STATUS uFR_int_DesfireClearRecordFile_TransMac_aes(
               uint8_t aes_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id,
               uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireClearRecordFile_TransMac_des(
               uint8_t des_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id,
               uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireClearRecordFile_TransMac_2k3des(
               uint8_t des2k_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id,
               uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireClearRecordFile_TransMac_3k3des(
               uint8_t des3k_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id,
               uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireClearRecordFile_TransMac_aes_PK(
               uint8_t *aes_key_ext, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id,
               uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireClearRecordFile_TransMac_des_PK(
               uint8_t *des_key_ext, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id,
               uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireClearRecordFile_TransMac_2k3des_PK(
               uint8_t *des2k_key_ext, uint32_t aid,
               uint8_t aid_key_nr, uint8_t file_id,
               uint16_t *card_status,
               uint16_t *exec_time, uint8_t use_reader_id,
               uint8_t *reader_id,uint8_t *prev_enc_reader_id,
                    uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_int_DesfireClearRecordFile_TransMac_3k3des_PK(
               uint8_t *des3k_key_ext, uint32_t aid,
               uint8_t aid_key_nr, uint8_t file_id,
               uint16_t *card_status,
               uint16_t *exec_time, uint8_t use_reader_id,
               uint8_t *reader_id, uint8_t *prev_enc_reader_id,
                    uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireClearRecordFile_TransMac_AesAuth(
               uint8_t aes_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id,
               uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireClearRecordFile_TransMac_DesAuth(
               uint8_t des_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id,
               uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireClearRecordFile_TransMac_2k3desAuth(
               uint8_t des2k_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id,
               uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
UFR_STATUS uFR_SAM_DesfireClearRecordFile_TransMac_3k3desAuth(
               uint8_t des3k_key_nr, uint32_t aid, uint8_t aid_key_nr,
               uint8_t file_id,
               uint16_t *card_status, uint16_t *exec_time,
                    uint8_t use_reader_id, uint8_t *reader_id,
               uint8_t *prev_enc_reader_id,
               uint32_t *trans_mac_cnt, uint8_t *trans_mac_value);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext **des_key_ext** **des2k_key_ext** **des3k_key_ext**	pointer to 16 bytes array containing the AES key pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aid	ID of application that contains the file
aid_key_nr	key number into application
file_id	ID of file (0 – 31)
card_status	pointer to card error variable
exec_time	function's execution time
use_reader_id	0 - Reader ID is not used, 1- Reader ID is used
reader_id	pointer to 16 bytes array containing the Reader ID
prev_enc_reader_id	pointer to 16 bytes array containing the Previous Encrypted Reader ID
trans_mac_cnt	pointer to value of Transaction MAC counter
trans_mac_value	pointer to 8 bytes array containing Transaction MAC

dfl_get_file_settings

From library version 5.0.29 and firmware version 5.0.32. Desfire Light specific command.

Function description

Function returns file settings.

Function declaration (C language)

```
UFR_STATUS DL_API dfl_get_file_settings(uint8_t file_no,
                              VAR uint8_t *file_type,
                              VAR uint8_t *communication_mode,
                              VAR uint8_t *read_key_no,
                              VAR uint8_t *write_key_no,
                              VAR uint8_t *read_write_key_no,
                              VAR uint8_t *change_key_no,
                              VAR uint32_t *file_size,
                              VAR int32_t *lower_limit,
                              VAR int32_t *upper_limit,
                              VAR uint32_t *limited_credit_value,
                              VAR uint8_t *limited_credit_enable,
                              VAR uint8_t *free_get_value,
                              VAR uint32_t *record_size,
                              VAR uint32_t *max_number_of_rec,
                              VAR uint32_t *curr_number_of_rec,
                              VAR uint8_t *ex_unauth_operation,
                              VAR uint8_t *tmc_limit_conf,
                              VAR uint8_t *tm_key_type,
                              VAR uint8_t *tm_key_version,
                              VAR uint32_t *tmc_limit);
```

Parameters

file_no	file number 0, 1, 3, 4, 15 or 31
*file_type	file type 0 - standard data file, 2 - value file, 4 - cyclic record file, 5 - transaction MAC file
*communication_mode	communication mode 0 - plain, 1 - macked, 3 - enciphered
*read_key_no	read key number (0 - 4)
*write_key_no	write key number (0 - 4)
*read_write_key_no	read write key number (0 - 4)
*change_key_no	change key number (0 - 4)
*file_size	standard data file size
*lower_limit	value file lower limit
*upper_limit	value file upper limit
*limited_credit_value	value file limited credit value
*limited_credit_enable	value file limited credit enable (0 - disabled, 1 - enabled)
*free_get_value	value file get value without authentication (0 - disabled, 1 - enabled)
*record_size	cyclic record file size of record
*max_number_of_rec	cyclic record file maximal number of record
*curr_number_of_rec	cyclic record file number of used record
*ex_unauth_operation	TMC file exclude unauthorised operation
*tmc_limit_conf	TMC file limit configuration
*tm_key_type	TMC file key type AES
*tm_key_version	TMC key version
*tmc_limit	TMC file counter limit

dfl_change_file_settings
dfl_change_file_settings_pk

From library version 5.0.29 and firmware version 5.0.32. Desfire Light specific command.

Function description
Function changes file settings.

Function declaration (C language)

```
UFR_STATUS dfl_change_file_settings_pk(IN uint8_t *aes_key_ext,
                                   uint8_t file_no,
                                   uint8_t key_no,
                                   uint8_t curr_communication_mode,
                                   uint8_t new_communication_mode,
                                   uint8_t read_key_no,
                                   uint8_t write_key_no,
                                   uint8_t read_write_key_no,
                                   uint8_t change_key_no);
UFR_STATUS dfl_change_file_settings(uint8_t aes_key_no,
                                   uint8_t file_no,
                                   uint8_t key_no,
                                   uint8_t curr_communication_mode,
                                   uint8_t new_communication_mode,
                                   uint8_t read_key_no,
                                   uint8_t write_key_no,
                                   uint8_t read_write_key_no,
                                   uint8_t change_key_no);
```

Parameters

***aes_key_ext**	pointer to array contained AES key
aes_key_no	reader key number of AES key (0 -15)
file_no	file number 0, 1, 3, 4, 15 or 31
curr_communication_mode	current communication mode 0 - plain, 1 - macked, 3 - enciphered
new_communication_mode	new communication mode 0 - plain, 1 - macked, 3 - enciphered
read_key_no	read key number (0 - 4)
write_key_no	write key number (0 - 4)
read_write_key_no	read write key number (0 - 4)
change_key_no	change key number (0 - 4)

dfl_delete_tmc_file
dfl_delete_tmc_file_pk

From library version 5.0.29 and firmware version 5.0.32. Desfire Light specific command.

Function description
Function delete transaction MAC file.

NOTE: Transaction MAC file exist by factory default. To use the operations with value file, and cyclic record file, this file must be deleted.

From library version 5.0.37 and firmware version 5.0.38, Transaction MAC operation supported for Desfire Light and Desfire EV2. To use these features, an Transaction MAC file must exist in the selected application.

Function declaration (C language)

```
UFR_STATUS dfl_delete_tmc_file_pk(IN uint8_t *aes_key_ext,
                                  uint8_t file_no);
UFR_STATUS dfl_delete_tmc_file(uint8_t aes_key_no,
                                  uint8_t file_no);
```

Parameters

`*aes_key_ext`	pointer to array contained AES key
`aes_key_no`	reader key number of AES key (0 -15)
`file_no`	file number 15

uFR_int_DesfireCreateTransMacFile_aes
uFR_int_DesfireCreateTransMacFile_des
uFR_int_DesfireCreateTransMacFile_2k3des
uFR_int_DesfireCreateTransMacFile_3k3des
uFR_int_DesfireCreateTransMacFile_aes_PK
uFR_int_DesfireCreateTransMacFile_des_PK
uFR_int_DesfireCreateTransMacFile_2k3des_PK
uFR_int_DesfireCreateTransMacFile_3k3des_PK
uFR_SAM_DesfireCreateTransMacFileAesAuth
uFR_SAM_DesfireCreateTransMacFileDesAuth
uFR_SAM_DesfireCreateTransMacFile2k3desAuth
uFR_SAM_DesfireCreateTransMacFile3k3desAuth

From library version 5.0.37 and firmware version 5.0.38. For Desfire Light, and Desfire EV2.

Function description
Function creates Transaction MAC file in application.

Function declaration (C language)

```
UFR_STATUS DL_API uFR_int_DesfireCreateTransMacFile_aes(
               uint8_t aes_key_nr, uint32_t aid, uint8_t file_id,
               uint8_t read_key_no,
               uint8_t commit_reader_id_key_no,
               uint8_t change_key_no, uint8_t communication_settings,
               uint8_t *trans_mac_key,
               uint16_t *card_status, uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireCreateTransMacFile_des(
               uint8_t des_key_nr, uint32_t aid, uint8_t file_id,
               uint8_t read_key_no,
               uint8_t commit_reader_id_key_no,
               uint8_t change_key_no, uint8_t communication_settings,
               uint8_t *trans_mac_key,
               uint16_t *card_status, uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireCreateTransMacFile_2k3des(
               uint8_t des2k_key_nr, uint32_t aid, uint8_t file_id,
               uint8_t read_key_no,
               uint8_t commit_reader_id_key_no,
               uint8_t change_key_no, uint8_t communication_settings,
               uint8_t *trans_mac_key,
               uint16_t *card_status, uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireCreateTransMacFile_3k3des(
               uint8_t des3k_key_nr, uint32_t aid, uint8_t file_id,
               uint8_t read_key_no,
               uint8_t commit_reader_id_key_no,
               uint8_t change_key_no, uint8_t communication_settings,
               uint8_t *trans_mac_key,
               uint16_t *card_status, uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireCreateTransMacFile_aes_PK(
               uint8_t *aes_key_ext, uint32_t aid, uint8_t file_id,
               uint8_t read_key_no,
               uint8_t commit_reader_id_key_no,
               uint8_t change_key_no, uint8_t communication_settings,
               uint8_t *trans_mac_key,
               uint16_t *card_status, uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireCreateTransMacFile_des_PK(
               uint8_t *des_key_ext, uint32_t aid, uint8_t file_id,
               uint8_t read_key_no,
               uint8_t commit_reader_id_key_no,
               uint8_t change_key_no, uint8_t communication_settings,
               uint8_t *trans_mac_key,
               uint16_t *card_status, uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireCreateTransMacFile_2k3des_PK(
               uint8_t *des2k_key_ext, uint32_t aid, uint8_t file_id,
               uint8_t read_key_no,
               uint8_t commit_reader_id_key_no,
               uint8_t change_key_no, uint8_t communication_settings,
               uint8_t *trans_mac_key,
               uint16_t *card_status, uint16_t *exec_time);
UFR_STATUS DL_API uFR_int_DesfireCreateTransMacFile_3k3des_PK(
               uint8_t *des3k_key_ext, uint32_t aid, uint8_t file_id,
               uint8_t read_key_no,
               uint8_t commit_reader_id_key_no,
               uint8_t change_key_no, uint8_t communication_settings,
               uint8_t *trans_mac_key,
               uint16_t *card_status, uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireCreateTransMacFileAesAuth(
               uint8_t aes_key_nr, uint32_t aid, uint8_t file_id,
               uint8_t read_key_no,
               uint8_t commit_reader_id_key_no,
               uint8_t change_key_no, uint8_t communication_settings,
               uint8_t *trans_mac_key,
               uint16_t *card_status, uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireCreateTransMacFileDesAuth(
               uint8_t des_key_nr, uint32_t aid, uint8_t file_id,
               uint8_t read_key_no,
               uint8_t commit_reader_id_key_no,
               uint8_t change_key_no, uint8_t communication_settings,
               uint8_t *trans_mac_key,
               uint16_t *card_status, uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireCreateTransMacFile2k3desAuth(
               uint8_t des2k_key_nr, uint32_t aid, uint8_t file_id,
               uint8_t read_key_no,
               uint8_t commit_reader_id_key_no,
               uint8_t change_key_no, uint8_t communication_settings,
               uint8_t *trans_mac_key,
               uint16_t *card_status, uint16_t *exec_time);
UFR_STATUS DL_API uFR_SAM_DesfireCreateTransMacFile3k3desAuth(
               uint8_t des3k_key_nr, uint32_t aid, uint8_t file_id,
               uint8_t read_key_no,
               uint8_t commit_reader_id_key_no,
               uint8_t change_key_no, uint8_t communication_settings,
               uint8_t *trans_mac_key,
               uint16_t *card_status, uint16_t *exec_time);
```

Parameters

aes_key_nr **des_key_nr** **des2k_key_nr** **des3k_key_nr**	ordinal number of AES key in the reader ordinal number of DES key in the reader ordinal number of 2K3DES key in the reader ordinal number of 3K3DES key in the reader
aes_key_ext	pointer to 16 bytes array containing the AES key

des_key_ext **des2k_key_ext** **des3k_key_ext**	pointer to 8 bytes array containing the DES key pointer to 16 bytes array containing the 2K3DES key pointer to 24 bytes array containing the 3K3DES key
aid	ID of application that contains the file
file_id	ID of file (0 – 31)
read_key_no	key for reading
commit_reader_id_key_no	key for commit Reader ID command
change_key_no	key for changing this setting
communication_settings	communication settings
trans_mac_key	pointer to 16 bytes array containing Transaction MAC key
card_status	pointer to card error variable
exec_time	function's execution time

dfl_check_credit_value_transaction_mac

From library version 5.0.37 and firmware version 5.0.38. For Desfire Light, and Desfire EV2.

Function description

Helper function for check transaction MAC in credit value operation. Function also returns decrypted Previous Reader ID. User must enter file number, value of credit, transaction MAC counter, card UID, transaction MAC key, Reader ID, encrypted Previous Reader ID and transaction MAC.

Function declaration (C language)

```
UFR_STATUS dfl_check_credit_value_transaction_mac(
          uint8_t file_no, uint32_t value, uint32_t trans_mac_counter,
          uint8_t *uid, uint8_t *trans_mac_key,
          uint8_t *reader_id, uint8_t *prev_enc_reader_id,
          uint8_t *trans_mac_value, uint8_t *prev_reader_id);
```

Parameters

file_no	file number
value	value of credit
trans_mac_counter	transaction MAC counter
uid	pointer to 7 bytes array containing card UID
trans_mac_key	pointer to 16 bytes array containing Transaction MAC key
reader_id	pointer to 16 bytes array containing Reader ID
prev_enc_reader_id	pointer to 16 bytes array containing Previous Encrypted Reader ID
trans_mac_value	pointer to 8 bytes array containing Transaction MAC
prev_reader_id	pointer to 16 bytes array containing Previous Reader ID

dfl_check_debit_value_transaction_mac

From library version 5.0.37 and firmware version 5.0.38. For Desfire Light, and Desfire EV2.

Function description

Helper function for check transaction MAC in debit value operation. Function also returns decrypted Previous Reader ID. User must enter file number, value of credit, transaction MAC counter, card UID, transaction MAC key, Reader ID, encrypted Previous Reader ID and transaction MAC.

Function declaration (C language)

```
UFR_STATUS dfl_check_debit_value_transaction_mac(
          uint8_t file_no, uint32_t value, uint32_t trans_mac_counter,
          uint8_t *uid, uint8_t *trans_mac_key,
          uint8_t *reader_id, uint8_t *prev_enc_reader_id,
          uint8_t *trans_mac_value, uint8_t *prev_reader_id);
```

Parameters

file_no	file number
value	value of debit
trans_mac_counter	transaction MAC counter
uid	pointer to 7 bytes array containing card UID
trans_mac_key	pointer to 16 bytes array containing Transaction MAC key
reader_id	pointer to 16 bytes array containing Reader ID
prev_enc_reader_id	pointer to 16 bytes array containing Previous Encrypted Reader ID
trans_mac_value	pointer to 8 bytes array containing Transaction MAC
prev_reader_id	pointer to 16 bytes array containing Previous Reader ID

desfire_check_write_record_transaction_mac
dfl_check_write_record_transaction_mac

From library version 5.0.37 and firmware version 5.0.38. For Desfire Light, and Desfire EV2.

Function description
Helper function for check transaction MAC in write record operation. Function also returns decrypted Previous Reader ID. User must enter file number, data offset, data length, array of data, transaction MAC counter, card UID, transaction MAC key, Reader ID, encrypted Previous Reader ID and transaction MAC.

Function declaration (C language)

```
UFR_STATUS desfire_check_write_record_transaction_mac(
          uint8_t file_no, uint32_t offset, uint32_t data_len,
          uint8_t *data, uint32_t trans_mac_counter, uint8_t *uid,
          uint8_t *trans_mac_key, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint8_t *trans_mac_value,
          uint8_t *prev_reader_id);
UFR_STATUS dfl_check_write_record_transaction_mac(
          uint8_t file_no, uint32_t offset, uint32_t data_len,
          uint8_t *data, uint32_t trans_mac_counter, uint8_t *uid,
          uint8_t *trans_mac_key, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint8_t *trans_mac_value,
          uint8_t *prev_reader_id);
```

Parameters

file_no	file number
offset	data offset
data_len	length of array of data
data	pointer to data array
trans_mac_counter	transaction MAC counter
uid	pointer to 7 bytes array containing card UID
trans_mac_key	pointer to 16 bytes array containing Transaction MAC key
reader_id	pointer to 16 bytes array containing Reader ID
prev_enc_reader_id	pointer to 16 bytes array containing Previous Encrypted Reader ID
trans_mac_value	pointer to 8 bytes array containing Transaction MAC
prev_reader_id	pointer to 16 bytes array containing Previous Reader ID

desfire_check_clear_record_transaction_mac

From library version 5.0.37 and firmware version 5.0.38. For Desfire Light, and Desfire EV2.

Function description

Helper function for check transaction MAC in clear record operation. Function also returns decrypted Previous Reader ID. Users must enter file number, transaction MAC counter, card UID, transaction MAC key, Reader ID, encrypted Previous Reader ID and transaction MAC.

Function declaration (C language)

```
UFR_STATUS desfire_check_clear_record_transaction_mac(
          uint8_t file_no, uint32_t trans_mac_counter, uint8_t *uid,
          uint8_t *trans_mac_key, uint8_t *reader_id,
          uint8_t *prev_enc_reader_id, uint8_t *trans_mac_value,
          uint8_t *prev_reader_id);
```

Parameters

`file_no`	file number
`trans_mac_counter`	transaction MAC counter
`uid`	pointer to 7 bytes array containing card UID
`trans_mac_key`	pointer to 16 bytes array containing Transaction MAC key
`reader_id`	pointer to 16 bytes array containing Reader ID
`prev_enc_reader_id`	pointer to 16 bytes array containing Previous Encrypted Reader ID
`trans_mac_value`	pointer to 8 bytes array containing Transaction MAC
`prev_reader_id`	pointer to 16 bytes array containing Previous Reader ID

uFR_int_DesfireUidReadECCSignature
uFR_int_DesfireRidReadECCSignature_des_PK
uFR_int_DesfireRidReadECCSignature_2k3des_PK
uFR_int_DesfireRidReadECCSignature_3k3des_PK
uFR_int_DesfireRidReadECCSignature_aes_PK
uFR_int_DesfireRidReadECCSignature_des
uFR_int_DesfireRidReadECCSignature_2k3des
uFR_int_DesfireRidReadECCSignature_3k3des
uFR_int_DesfireRidReadECCSignature_aes

From library version 5.0.45 and firmware version 5.0.44. For Desfire Light, and Desfire EV2.

Function description

Function retrieves the asymmetric originality signature based on an asymmetric cryptographic algorithm Elliptic Curve Cryptography Digital Signature Algorithm (ECDSA). If the Random ID is activated, then the authentication with a valid key required.

Function declaration (C language)

```
UFR_STATUS uFR_int_DesfireUidReadECCSignature(
                         OUT uint8_t *lpucECCSignature,
                         OUT uint8_t *card_uid,
                         VAR uint8_t *lpucDlogicCardType);
UFR_STATUS uFR_int_DesfireRidReadECCSignature_des_PK(
                         IN uint8_t *auth_key_ext,
                         uint32_t aid, uint8_t aid_key_nr,
                         OUT uint8_t *card_uid,
                         OUT uint8_t *lpucECCSignature,
                         VAR uint8_t *lpucDlogicCardType);
UFR_STATUS DL_API uFR_int_DesfireRidReadECCSignature_2k3des_PK(
                         IN uint8_t *auth_key_ext,
                         uint32_t aid, uint8_t aid_key_nr,
                         OUT uint8_t *card_uid,
                         OUT uint8_t *lpucECCSignature,
                         VAR uint8_t *lpucDlogicCardType);
UFR_STATUS DL_API uFR_int_DesfireRidReadECCSignature_3k3des_PK(
                         IN uint8_t *auth_key_ext,
                         uint32_t aid, uint8_t aid_key_nr,
                         OUT uint8_t *card_uid,
                         OUT uint8_t *lpucECCSignature,
                         VAR uint8_t *lpucDlogicCardType);
UFR_STATUS DL_API uFR_int_DesfireRidReadECCSignature_aes_PK(
                         IN uint8_t *auth_key_ext,
                         uint32_t aid, uint8_t aid_key_nr,
                         OUT uint8_t *card_uid,
                         OUT uint8_t *lpucECCSignature,
                         VAR uint8_t *lpucDlogicCardType);
UFR_STATUS DL_API uFR_int_DesfireRidReadECCSignature_des(
                         uint8_t auth_key_nr, uint32_t aid,
                         uint8_t aid_key_nr,
                         OUT uint8_t *card_uid,
                         OUT uint8_t *lpucECCSignature,
                         VAR uint8_t *lpucDlogicCardType);
UFR_STATUS DL_API uFR_int_DesfireRidReadECCSignature_2k3des(
                         uint8_t auth_key_nr, uint32_t aid,
                         uint8_t aid_key_nr,
                         OUT uint8_t *card_uid,
                         OUT uint8_t *lpucECCSignature,
                         VAR uint8_t *lpucDlogicCardType);
UFR_STATUS DL_API uFR_int_DesfireRidReadECCSignature_3k3des(
                         uint8_t auth_key_nr, uint32_t aid,
                         uint8_t aid_key_nr,
                         OUT uint8_t *card_uid,
                         OUT uint8_t *lpucECCSignature,
                         VAR uint8_t *lpucDlogicCardType);
UFR_STATUS DL_API uFR_int_DesfireRidReadECCSignature_aes(
                         uint8_t auth_key_nr, uint32_t aid,
                         uint8_t aid_key_nr,
                         OUT uint8_t *card_uid,
                         OUT uint8_t *lpucECCSignature,
                         VAR uint8_t *lpucDlogicCardType);
```

Parameters

`*auth_key_ext`	pointer to array containing the key
`auth_key_nr`	ordinal number of key in the reader
`aid`	ID of application that contains the file
`aid_key_nr`	key number into application
`*card_uid`	7 bytes length card UID
`*lpucECCSignature`	56 bytes ECC signature
`*lpucDlogicCardType`	pointer to variable which will (in case of successfully executed operation) receive DlogicCardType. Returned here for convenience. For DlogicCardType uFR API uses the same constants as with GetDlogicCardType() function (see Appendix: DLogic CardType enumeration).

Functions for Mifare Plus card (AES encryption in reader)

For uFR PLUS devices only.

AES encryption and decryption is performed in the reader. AES keys are stored into reader.

Specific functions for Mifare Plus card

UFR_STATUS	MFP_WritePerso
UFR_STATUS	MFP_CommitPerso
UFR_STATUS	MFP_PersonalizationMinimal
UFR_STATUS	MFP_SwitchToSecurityLevel3
UFR_STATUS	MFP_AesAuthSecurityLevel1
UFR_STATUS	MFP_ChangeMasterKey
UFR_STATUS	MFP_ChangeConfigurationKey

UFR_STATUS	MFP_FieldConfigurationSet
UFR_STATUS	MFP_ChangeSectorKey
UFR_STATUS	MFP_GetUid
UFR_STATUS	MFP_ChangeVcPollingEncKey
UFR_STATUS	MFP_ChangeVcPollingMacKey

MFP_WritePerso

Function description

Security level 0 command.

Function is used to change the data and AES keys from the initial delivery configuration to a customer specific value.

Function declaration (C language)

```
UFR_STATUS MFP_WritePerso(uint16_t address, uint8_t *data);
```

Parameters

address	Number of block or key
***data**	Value of data or AES key

MFP_CommitPerso

Function description

Security level 0 command.

Function is used to finalize the personalization and switch up to security level 1.

Function declaration (C language)

```
UFR_STATUS MFP_CommitPerso(void);
```

MFP_PersonalizationMinimal

Function description

Security level 0 command.

Function is used for card personalization. The minimum number of AES keys is entered into the card. There are card master key, card configuration key, key for switch to security level 2, key for switch to security level 3, security level 1 authentication key, virtual card select key, proximity check key, VC polling ENC and VC poling MAC key. Keys can not be changed at security level 1.

Other keys that are not personalized will have value
0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF (16 x 0xFF)

Function declaration (C language)

```
UFR_STATUS MFP_PersonalizationMinimal(
                              uint8_t *card_master_key,
                              uint8_t *card_config_key,
                              uint8_t *level_2_switch_key,
                              uint8_t *level_3_switch_key,
                              uint8_t *level_1_auth_key,
                              uint8_t *select_vc_key,
                              uint8_t *prox_chk_key,
                              uint8_t *vc_poll_enc_key,
                              uint8_t *vc_poll_mac_key);
```

Parameters

`*card_master_key`	pointer to 16 byte array containing the card master key
`*card_config_key`	pointer to 16 byte array containing the card configuration key
`*level_2_switch_key`	pointer to 16 byte array containing the key for switch to security level 2
`*level_3_switch_key`	pointer to 16 byte array containing the key for switch to security level 3
`*level_1_auth_key`	pointer to 16 byte array containing the key for optional authentication at security level 1
`*select_vc_key`	pointer to 16 byte array containing the key for virtual card selection
`*prox_chk_key`	pointer to 16 byte array containing the key for proximity check
`*vc_poll_enc_key`	pointer to 16 byte array containing the ENC key for virtual card polling
`*vc_poll_mac_key`	pointer to 16 byte array containing the MAC key for virtual card polling

MFP_AesAuthSecurityLevel1
MFP_AesAuthSecurityLevel1_PK

Function description

Security level 1 command.

Security level 1 offers the same functionality as a MIFARE Classic card.

Function is used to optional AES authentication.

Function declaration (C language)

```
UFR_STATUS MFP_AesAuthSecurityLevel1(uint8_t key_index);
UFR_STATUS MFP_AesAuthSecurityLevel1_PK(uint8_t *aes_key);
```

Parameters

key_index	ordinary number of AES key stored into reader (0 - 15)
***aes_key**	pointer to 16 byte array containing the AES key

MFP_SwitchToSecurityLevel3
MFP_SwitchToSecurityLevel3_PK

Function description

Security level 1 or 2 command.

Function is used to switch to security level 3.

Function declaration (C language)

```
UFR_STATUS MFP_SwitchToSecurityLevel3(uint8_t key_index);
UFR_STATUS MFP_SwitchToSecurityLevel3_PK(uint8_t *aes_key);
```

Parameters

key_index	ordinary number of AES key stored into reader (0 - 15)
***aes_key**	pointer to 16 byte array containing the AES key

MFP_ChangeMasterKey
MFP_ChangeMasterKey_PK
MFP_ChangeMasterKeySamKey

Function description

Security level 3 command.

The function is used to change the AES card master key value.

Function declaration (C language)

```
UFR_STATUS MFP_ChangeMasterKey(uint8_t key_index, uint8_t *new_key);
UFR_STATUS MFP_ChangeMasterKey_PK(uint8_t *old_key, uint8_t *new_key);
```

```
*only uFR CS with SAM support
```

```
UFR_STATUS MFP_ChangeMasterKeySamKey(uint8_t key_index, uint8_t
new_key_index);
```

Parameters

key_index	ordinary number of current master key stored into reader (0 - 15) or in SAM (1 - 127)
***old_key**	pointer to 16 byte array containing the current master key
***new key**	pointer to 16 byte array containing the new master key

MFP_ChangeConfigurationKey
MFP_ChangeConfigurationKey_PK
MFP_ChangeConfigurationKeySamKey

Function description

Security level 3 command.

The function is used to change the AES card configuration key value.

Function declaration (C language)

```
UFR_STATUS MFP_ChangeConfigurationKey(uint8_t key_index,
                                      uint8_t *new_key);
UFR_STATUS MFP_ChangeConfigurationKey_PK(uint8_t *old_key,
                                      uint8_t *new_key);
```

```
*only uFR CS with SAM support
```

```
UFR_STATUS MFP_ChangeConfigurationKeySamKey(uint8_t key_index,
                                        uint8_t new_key_index);
```

Parameters

key_index	ordinary number of current configuration key stored into reader (0 - 15) or in SAM (1 - 127)
***old_key**	pointer to 16 byte array containing the current configuration key
***new key**	pointer to 16 byte array containing the new configuration key

MFP_FieldConfigurationSet
MFP_FieldConfigurationSet_PK
MFP_FieldConfigurationSetSamKey

Function description

Security level 3 command.

Function is used for definition of using Random ID and Proximity check options. Authentication with AES card configuration key required.

Function declaration (C language)

```
UFR_STATUS MFP_FieldConfigurationSet(
                              uint8_t configuration_key_index,
                              uint8_t rid_use,
                              uint8_t prox_check_use);
UFR_STATUS DL_API MFP_FieldConfigurationSet_PK(
                              uint8_t *configuration_key,
                              uint8_t rid_use,
                              uint8_t prox_check_use);

*only uFR CS with SAM support
UFR_STATUS DL_API MFP_FieldConfigurationSetSamKey(
                              uint8_t configuration_key_index,
                              uint8_t rid_use,
                              uint8_t prox_check_use);
```

Parameters

`configuration_key_index`	ordinary number of configuration key stored into reader (0 - 15)
`*configuration_key`	pointer to 16 byte array containing the configuration key
`rid_use`	1 - Randnom ID enabled, 0 - Random ID disabled
`prox_check_use`	1- Proximity check is mandatory, 0 - Proximity check is not mandatory

MFP_ChangeSectorKey
MFP_ChangeSectorKey_PK
MFP_ChangeSectorKeySamKey

Function description

Security level 3 command.

In order to access the block in sector data, AES authentication is needed. Each sector has two

AES keys that can be used for authentication (Key A and Key B).

Default value if key is not personalized is 0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF (16 x 0xFF).

For linear read part of card, enter the same value of sector keys for all sectors which will be read at once.

Function declaration (C language)

```
UFR_STATUS MFP_ChangeSectorKey(
                                uint8_t sector_nr,
                                uint8_t auth_mode,
                                uint8_t key_index,
                                uint8_t *new_key);
UFR_STATUS MFP_ChangeSectorKey_PK(
                                uint8_t sector_nr,
                                uint8_t auth_mode_pk,
                                uint8_t *old_key,
                                uint8_t *new_key);
```

```
*only uFR CS with SAM support
```

```
UFR_STATUS DL_API MFP_ChangeSectorKeySamKey(
                               uint8_t sector_nr,
                               uint8_t auth_mode,
                               uint8_t key_index,
                               uint8_t new_key_index);
```

Parameters

sector_nr	ordinary number of sector (0 - 31) for 2K card, or (0 - 39) for 4K card.
auth_mode	MIFARE_AUTHENT1A for Key A or MIFARE_AUTHENT1B for Kye B
auth_mode_pk	MIFARE_PLUS_AES_AUTHENT1A for Key A or MIFARE_PLUS_AES_AUTHENT1B for Kye B
key_index	ordinary number of current sector key stored into reader (0 - 15)
***old_key**	pointer to 16 byte array containing the current sector key (A or B)
***new_key**	pointer to 16 byte array containing the new sector key (A or B)

MFP_GetUid
MFP_GetUid_PK
MFP_GetUidSamKey

Function description

Security level 3 command.

Function is used to read UID if Random ID is enabled. Authentication with AES VC Polling ENC Key and VC Polling MAC Key is mandatory.

Function declaration (C language)

```
UFR_STATUS MFP_GetUid(
                        uint8_t key_index_vc_poll_enc_key,
                        uint8_t key_index_vc_poll_mac_key,
                        uint8_t *uid, uint8_t *uid_len);
UFR_STATUS MFP_GetUid_PK(
                        uint8_t *vc_poll_enc_key,
                        uint8_t *vc_poll_mac_key,
                        uint8_t *uid, uint8_t *uid_len);

*only uFR CS with SAM support
UFR_STATUS MFP_GetUidSamKey(
                         uint8_t key_index_vc_poll_enc_key,
                         uint8_t key_index_vc_poll_mac_key,
                         uint8_t *uid,
                         uint8_t *uid_len);
```

Parameters

`key_index_vc_poll_enc_key`	ordinary number of VC polling ENC key stored into reader (0 - 15)
`key_index_vc_poll_mac_key`	ordinary number of VC polling MAC key stored into reader (0 - 15)
`*vc_poll_enc_key`	pointer to 16 byte array containing VC polling ENC key
`*vc_poll_mac_key`	pointer to 16 byte array containing VC polling MAC key
`*uid`	pointer to byte array containing the card UID
`*uid_len`	pointer to UID length variable

MFP_ChangeVcPollingEncKey
MFP_ChangeVcPollingEncKey_PK
MFP_ChangeVcPollingEncKeySamKey

Function description

Security level 3 command.

The function is used to change the AES VC polling ENC key value. Authentication with AES card configuration key is required.

Function declaration (C language)

```
UFR_STATUS DL_API MFP_ChangeVcPollingEncKey(
                                uint8_t configuration_key_index,
                                uint8_t *new_key);
UFR_STATUS DL_API MFP_ChangeVcPollingEncKey_PK(
                                uint8_t *configuration_key,
                                uint8_t *new_key);

*only uFR CS with SAM support

UFR_STATUS DL_API MFP_ChangeVcPollingEncKeySamKey(
                              uint8_t configuration_key_index,
                              uint8_t new_key_index);
```

Parameters

`configuration_key_index`	ordinary number of card configuration key stored into reader (0 - 15)
`*configuration_key`	pointer to 16 byte array containing card configuration key
`*new_key`	pointer to 16 byte array containing new VC Polling ENC key

MFP_ChangeVcPollingMacKey
MFP_ChangeVcPollingMacKey_PK
MFP_ChangeVcPollingMacKeySamKey

Function description

Security level 3 command.

The function is used to change the AES VC polling MAC key value. Authentication with AES card configuration key is required.

Function declaration (C language)

```
UFR_STATUS DL_API MFP_ChangeVcPollingMacKey(
                                uint8_t configuration_key_index,
                                uint8_t *new_key);
UFR_STATUS DL_API MFP_ChangeVcPollingMacKey_PK(
                                uint8_t *configuration_key,
                                uint8_t *new_key);
```

```
*only uFR CS with SAM support
```

```
UFR_STATUS DL_API MFP_ChangeVcPollingMacKeySamKey(
                              uint8_t configuration_key_index,
                              uint8_t new_key_index);
```

Parameters

`configuration_key_index`	ordinary number of card configuration key stored into reader (0 - 15)
`*configuration_key`	pointer to 16 byte array containing card configuration key
`*new_key`	pointer to 16 byte array containing new VC Polling MAC key

Originality checking

Some card chips supports originality checking mechanism using Elliptic Curve Digital Signature Algorithm (ECDSA). Chip families that support originality checking mechanism are NTAG 21x and Mifare Ultralight EV1. For details on originality checking, you must have an non-disclosure agreement (NDA) with the manufacturer who will provide you with the relevant documentation. In any case, the uFR API provides you with 2 functions that you can use for this purpose:

ReadECCSignature

Function description

This function returns the ECC signature of the card chip UID. Card chip UID is signed using EC private key known only to a manufacturer.

Function declaration (C language)

```
#define MAX_UID_LEN       10
#define ECC_SIG_LEN       32
UFR_STATUS ReadECCSignature(uint8_t lpucECCSignature[ECC_SIG_LEN],
                            uint8_t lpucUid[MAX_UID_LEN],
                            uint8_t *lpucUidLen,
                            uint8_t *lpucDlogicCardType);
```

Parameters

`lpucECCSignature`	pointer to array which (in case of successfully executed operation) will contain 32 bytes long ECDSA signature of the chip UID. Chip UID is signed using EC private key known only to a manufacturer.
`lpucUid`	pointer to a chip UID (in case of successfully executed operation). Returned here for convenience.
`*lpucUidLen`	pointer to variable which will (in case of successfully executed operation) receive true length of the returned UID. (Maximum UID length is 10 bytes but there is three possible UID sizes: 4, 7 and 10).
`*lpucDlogicCardType`	pointer to variable which will (in case of successfully executed operation) receive DlogicCardType. Returned here for convenience. For DlogicCardType uFR API uses the same constants as with GetDlogicCardType() function (see Appendix: DLogic CardType enumeration).

ReadECCSignatureExt

Function description
From library version 5.0.43 and firmware version 5.0.43.

This function returns the ECC signature of the card chip UID. Card chip UID is signed using EC private key known only to a manufacturer.

Unlike the ReadECCSignature function, this function supports ECC with variable length.

Function declaration (C language)

```
UFR_STATUS ReadECCSignatureExt(OUT uint8_t *lpucECCSignature,
                               VAR uint8_t *lpucECCSignatureLen,
                               OUT uint8_t *lpucUid,
                               VAR uint8_t *lpucUidLen,
                               VAR uint8_t *lpucDlogicCardType);
```

Parameters

`lpucECCSignature`	pointer to array which (in case of successfully executed operation) will contain ECDSA signature of the chip UID. Chip UID is signed using EC private key known only to a manufacturer.
`lpucECCSignatureLen`	pointer to ECC signature length
`lpucUid`	pointer to a chip UID (in case of successfully executed operation). Returned here for convenience.
`*lpucUidLen`	pointer to variable which will (in case of successfully executed operation) receive true length of the returned UID. (Maximum UID length is 10 bytes but there is three possible UID sizes: 4, 7 and 10).
`*lpucDlogicCardType`	pointer to variable which will (in case of successfully executed operation) receive DlogicCardType. Returned here for convenience. For DlogicCardType uFR API uses the same constants as with GetDlogicCardType() function (see Appendix: DLogic CardType enumeration).

OriginalityCheck

Function description

This function depends on OpenSSL crypto library. Since OpenSSL crypto library is dynamically linked during execution, the only prerequisite for a successful call to this function is that the libeay32.dll is in the current folder (valid for Windows) and / or libcrypto.so is in the environment path (e.g. LD_LIBRARY_PATH on Linux / macOS). `OriginalityCheck()` performs the check if the chip on the card / tag is NXP genuine.

Function declaration (C language)

```
UFR_STATUS OriginalityCheck(const uint8_t *signature,
                            const uint8_t *uid,
                            uint8_t uid_len,
                            uint8_t DlogicCardType);
```

Parameters

***signature**	ECCSignature acquired by call to the **ReadECCSignature()** function.
***uid**	Card UID. Best if the card UID is acquired by previous call to the **ReadECCSignature()** function.
uid_len	Card UID length. Best if the card UID length is acquired by previous call to the **ReadECCSignature()** function.
DlogicCardType	Card type. Best if the DlogicCardType is acquired by previous call to the **ReadECCSignature()** function.

UFR_STATUS specific error codes that can be returned by this function:

UFR_NOT_NXP_GENUINE	0x0200	if the chip on the card/tag ISN'T NXP GENUINE
UFR_OPEN_SSL_DYNAMIC_LIB_FAILED	0x0201	in case of OpenSSL library error (e.g. wrong OpenSSL version)
UFR_OPEN_SSL_DYNAMIC_LIB_NOT_FOUND	0x0202	in case there is no OpenSSL library (libeay32.dll on Windows systems, libcrypto.so on Linux and libcrypto.dylib on macOS) in current folder or environment path
UFR_OK	0	if the chip on the card/tag IS NXP GENUINE

NFC Type 2 Tags counters

There are different types of counters implemented in different families of the NFC T2T chips. Ultralight, NTAG 210 and NTAG 212 don't have counters.

Ultralight C and NTAG 203 have one 16-bit one-way counter which can be managed using BlockRead and BlockWrite API functions on the appropriate block address (for those two chips, counter page address is 0x29.

Ultralight EV1 variants have three independent 24-bit one-way counters which can be managed using ReadCounter() and IncrementCounter() API functions. Counters are mapped in a separate address space.

NTAG 213, NTAG 215 and NTAG 216 have a 24-bit NFC counter which is incremented on every first valid occurrence of the READ or FAST-READ command (ISO 14443-3A proprietary commands) after the tag is powered by an RF field. There is no other way to change the value of the 24-bit NFC counter and there is a mechanism to enable it or disable it. This counter can be read using ReadNFCCounter() API function if password authentication is not in use. API functions ReadNFCCounterPwdAuth_RK() or ReadNFCCounterPwdAuth_PK() can be used to read NFC counter if it’s protected with the password authentication. 24-bit NFC counter have counter address 2 (counter is mapped in a separate address space) so ReadCounter(2, &value) call is equivalent to a ReadNFCCounter(&value) if password authentication isn’t in use.

ReadCounter

Function description
This function is used to read one of the three 24-bit one-way counters in Ultralight EV1 chip family. Those counters can’t be password protected. In the initial Ultralight EV1 chip state, the counter values are set to 0.

Function declaration (C language)

```
UFR_STATUS ReadCounter(uint8_t counter_address, uint32_t *value);
```

Parameters

`counter_address`	Address of the target counter. Can be in range 0 to 2. Counters are mapped in a separate address space.
`*value`	Pointer to a uint32_t which will contained counter value after successful function execution. Since counters are 24-bit in length, most significant byte of the *value will be always 0.

IncrementCounter

Function description
This function is used to increment one of the three 24-bit one-way counters in Ultralight EV1 chip family. Those counters can’t be password protected. If the sum of the addressed counter value and the increment value is higher than 0xFFFFFF, the tag replies with an error and does not update the respective counter.

Function declaration (C language)

```
UFR_STATUS IncrementCounter(uint8_t counter_address, uint32_t
inc_value);
```

Parameters

`counter_address`	Address of the target counter. Can be in range 0 to 2. Counters are mapped in a separate address space.
`inc_value`	Increment value. Only the 3 least significant bytes are relevant.

ReadNFCCounter

Function description

This function is used to read 24-bit NFC counters in NTAG 213, NTAG 215 and NTAG 216 chips without using password authentication. If access to the NFC counter is configured to be password protected, this function will return COUNTER_ERROR.

Function declaration (C language)

```
UFR_STATUS ReadNFCCounter(uint32_t *value);
```

Parameter

`*value`	Pointer to a uint32_t which will contain counter value after successful function execution. Since counter is 24-bit in length, most significant byte of the *value will always be 0.

ReadNFCCounterPwdAuth_RK

Function description

This function is used to read 24-bit NFC counter in NTAG 213, NTAG 215 and NTAG 216 chips using “reader key password authentication”. If access to NFC counter is configured to be password protected and PWD-PACK pair stored as a 6-byte key in uFR reader disagrees with PWD-PACK pair configured in tag, this function will return UFR_AUTH_ERROR. If access to NFC counter isn’t configured to be password protected, this function will return UFR_AUTH_ERROR.

Function declaration (C language)

```
UFR_STATUS ReadNFCCounterPwdAuth_RK(uint32_t *value,
                                    uint8_t reader_key_index);
```

Parameters

`*value`	Pointer to a uint32_t which will contained counter value after successful function execution. Since counter is 24-bit in length, most significant byte of the *value will be always 0.
`reader_key_index`	Index of the 6-byte key (PWD-PACK pair for this type of NFC tags) stored in the uFR reader. Can be in range 0 to 31.

ReadNFCCounterPwdAuth_PK

Function description

This function is used to read 24-bit NFC counter in NTAG 213, NTAG 215 and NTAG 216 chips using “provided key password authentication”. If access to NFC counter is configured to be password protected and PWD-PACK pair sent as a 6-byte provided key disagrees with PWD-PACK pair configured in tag, this function will return UFR_AUTH_ERROR. If access to NFC counter isn’t configured to be password protected, this function will return UFR_AUTH_ERROR.

Function declaration (C language)

```
UFR_STATUS ReadNFCCounterPwdAuth_PK(uint32_t *value, const uint8_t
*key);
```

Parameters

`*value`	Pointer to a uint32_t which will contained counter value after successful function execution. Since counter is 24-bit in length, most significant byte of the *value will be always 0.
`*key`	Pointer to an array contains provided 6-byte key (PWD-PACK pair for this type of NFC tags) for password authentication.

Functions for the operating parameters of the reader setting

UfrSetBadSelectCardNrMax

Function description

The function allows you to set the number of unsuccessful card selections before it can be considered that the card is not placed on the reader. Period between two card selections is approximately 10ms. Default value of this parameter is 20 i.e. 200ms. This parameter can be set

in the range of 0 to 254.
This is useful for asynchronous card ID transmission, if parameter send_removed_enable in function SetAsyncCardIdSendConfig is set. Then you can set a lower value of the number of unsuccessful card selections, in order to send information to the card removed was faster.
A small value of this parameter may cause a false report that the card is not present, and immediately thereafter true report that the card is present.

Function declaration (C language)
`UFR_STATUS UfrSetBadSelectCardNrMax(uint8_t bad_select_nr_max);`
Parameter

`bad_select_nr_max`	number of unsuccessful card selections

UfrGetBadSelectCardNrMax

Function description
The function returns value of maximal unsuccessful card selections, which is set in reader.

Function declaration (C language)
`UFR_STATUS UfrGetBadSelectCardNrMax(uint8_t *bad_select_nr_max);`
Parameter

`bad_select_nr_max`	pointer to number of unsuccessful card selections

Functions for all blocks linear reading

Function description
Functions allow you to quickly read data from the card including the sector trailer blocks. These functions are very similar to the functions for linear reading of users data space.

- *LinearRowRead*
- *LinearRowRead_AKM1*
- *LinearRowRead_AKM2*
- *LinearRowRead_PK*

Functions declaration (C language):

```
UFR_STATUS LinearRowRead(uint8_t *aucData,
                 uint16_t usLinearAddress,
                 uint16_t usDataLength,
                 uint16_t *lpusBytesReturned,
                 uint8_t ucAuthMode,
                 uint8_t ucReaderKeyIndex);
UFR_STATUS LinearRowRead_AKM1(uint8_t *aucData,
                          uint16_t usLinearAddress,
                          uint16_t usDataLength,
                          uint16_t *lpusBytesReturned,
                          uint8_t ucAuthMode);
UFR_STATUS LinearRowRead_AKM2(uint8_t *aucData,
                        uint16_t usLinearAddress,
                        uint16_t usDataLength,
                        uint16_t *lpusBytesReturned,
                        uint8_t ucAuthMode);
UFR_STATUS LinearRowRead_PK(uint8_t *aucData,
                        uint16_t usLinearAddress,
                        uint16_t usDataLength,
                        uint16_t *lpusBytesReturned,
                        uint8_t ucAuthMode,
                        uint8_t *aucProvidedKey);
```

Parameters

aucData	Pointer to the sequence of bytes where read data will be stored
usLinearAddress	Linear address on the card from which the data want to read
usDataLength	Number of bytes for reading. For aucData a minimum usDataLength bytes must be allocated before calling the function
lpusBytesReturned	Pointer to "uint16_t" type variable, where the number of successfully read bytes from the card is written. If the reading is fully managed this data is equal to the usDataLength parameter. If there is an error reading some of the blocks, the function returns all successfully read data in the aucData before the errors occurrence and the number of successfully read bytes is returned via this parameter
ucAuthMode	This parameter defines whether to perform authentication with key A or key B. It can have two values, namely: AUTHENT1A (0x60) or AUTHENT1B (0x61)

ucReaderKeyIndex	The default method of authentication (when the functions without a suffix is used) performs the authenticity proving by using the selected key index from the reader. In the linear address mode, this applies to all sectors that are read
aucProvidedKey	Pointer to the six-byte string containing the key for authenticity proving in the "Provided Key" method. _PK Suffix in the name of the function indicates this method usage

FUNCTIONS FOR READER LOW POWER MODE CONTROL

UfrEnterSleepMode

Function description

Function allows enter to reader low power working mode. Reader is in sleep mode. RF field is turned off. The reader is waiting for the command to return to normal working mode.

Function declaration (C language)

```
UFR_STATUS UfrEnterSleepMode(void);
```

UfrLeaveSleepMode

Function description

Function allows return from low power reader mode to normal working mode. This function wake up uFR, returning success status. Any other command returns COMMUNICATION_BREAK status.

Function declaration (C language):

```
UFR_STATUS UfrLeaveSleepMode(void);
```

AutoSleepSet

Function description

This function permanently set auto-sleep functionality of the device. Valid seconds_wait range is from 1 to 254. To permanently disable auto-sleep functionality use 0 or 0xFF for the seconds_wait parameter.

Function declaration (C language)

```
unsigned long AutoSleepSet(uint8_t seconds_wait);
```

Parameter

`seconds_wait`	device inactivity time before entering into sleep mode

AutoSleepGet

Function description

This function uses to get auto-sleep functionality setup from the device. You have to send pointer to already allocated variable of the uint8_t type. If auto-sleep functionality is disabled you will get 0 or 0xFF in the variable pointed by the *seconds_wait parameter.

Function declaration (C language)

```
unsigned long AutoSleepGet(uint8_t *seconds_wait);
```

Parameter

`seconds_wait`	device inactivity time before entering into sleep mode

Functions for Reader NTAG Emulation Mode

WriteEmulationNdef

Function description

Function stores a message record for NTAG emulation mode into the reader. Parameters of the function are: TNF, type of record, ID, payload. Maximum total size for emulated NDEF message is 144 bytes.

Function declaration (C language)

```
UFR_STATUS WriteEmulationNdef(uint8_t tnf,
                              uint8_t* type_record,
                              uint8_t type_length,
                              uint8_t* id,
                              uint8_t id_length,
                              uint8_t* payload,
                              uint8_t payload_length);
```

Parameters

`tnf`	TNF of the record
`type_record`	pointer to the array containing record type
`type_length`	length of the record type
`id`	pointer to the array containing record ID
`id_length`	length of the record ID
`payload`	pointer to the array containing record payload
`payload_length`	length of the record payload

Possible error codes:

```
WRITE_VERIFICATION_ERROR = 0x70
MAX_SIZE_EXCEEDED = 0x10
```

WriteEmulationNdefWithAAR

Function description

This function do the same as WriteEmulationNdef() function with the addition of an AAR embedded in to the NDEF message. AAR stands for “Android Application Record”. AAR is a special type of NDEF record that is used by Google’s Android operating system to signify to an NFC phone that an explicitly defined Android Application which should be used to handle an emulated NFC tag. Android App record will be added as the 2nd NDEF record in the NDEF message.

Function declaration (C language)

```
UFR_STATUS          WriteEmulationNdefWithAAR(uint8_t          tnf,
                                          uint8_t  *type_record,
                                           uint8_t  type_length,

                                                  uint8_t  *id,
                                            uint8_t  id_length,
                                             uint8_t  *payload,
                                       uint8_t  payload_length,
                                                 uint8_t  *aar,
                              uint8_t aar_length);
```

Parameters

`tnf`	TNF of the record
`type_record`	pointer to the array containing record type
`type_length`	length of the record type
`id`	pointer to the array containing record ID
`id_length`	length of the record ID
`payload`	pointer to the array containing record payload
`payload_length`	length of the record payload
`aar`	pointer to the array containing AAR record
`aar_length`	length of the AAR record

TagEmulationStart

Function description

Put the reader permanently in a NDEF tag emulation mode. Only way for a reader to exit from this mode is to receive the TAG_EMULATION_STOP command (issued by calling **`TagEmulationStop()`** function).

In this mode, the reader can only answer to the commands issued by a following library functions:

`TagEmulationStart()`,

`WriteEmulationNdef()`,

`TagEmulationStop()`,

`GetReaderSerialNumber()`,

```
GetReaderSerialDescription(),

GetReaderHardwareVersion(),

GetReaderFirmwareVersion(),

GetBuildNumber()
```

Calls to the other functions in this mode returns following error code:

```
      FORBIDDEN_IN_TAG_EMULATION_MODE = 0x90
```

Function declaration (C language)

```
UFR_STATUS TagEmulationStart(void);
```

Possible error codes:

```
      WRITE_VERIFICATION_ERROR = 0x70
```

(command resulting in a direct write to a device non-volatile memory)

TagEmulationStop

Function description

Allows the reader permanent exit from a NDEF tag emulation mode.

Function declaration (C language)

```
UFR_STATUS TagEmulationStop(void);
```

Possible error codes:

```
      WRITE_VERIFICATION_ERROR = 0x70
```

(command resulting in a direct write to a device non-volatile memory)

WriteEmulationNdefRam

From library version 5.0.31, and firmware version 5.0.33

Function description

Function stores a message record for NTAG emulation mode into the reader in the RAM. Parameters of the function are: TNF, type of record, ID, payload. Maximum total size for emulated NDEF message is 1008 bytes. Unlike the function WriteEmulationNdef, the data is not written to the EEPROM of the reader, so they cannot be loaded after the reader is reset. This function must be called after reader reset to use the NTAG emulation.

Function declaration (C language)

```
UFR_STATUS WriteEmulationNdefRam(uint8_t tnf,
                                 uint8_t* type_record,
                                 uint8_t type_length,
                                 uint8_t* id,
                                 uint8_t id_length,
                                 uint8_t* payload,
                                 uint8_t payload_length);
```

Parameters

tnf	TNF of the record
type_record	pointer to the array containing record type
type_length	length of the record type
id	pointer to the array containing record ID
id_length	length of the record ID
payload	pointer to the array containing record payload
payload_length	length of the record payload

Possible error codes:

```
MAX_SIZE_EXCEEDED = 0x10
```

TagEmulationStartRam

From library version 5.0.31, and firmware version 5.0.33

Function description

Put the reader permanently in a NDEF tag in RAM emulation mode. Only way for a reader to exit from this mode is to receive the TAG_EMULATION_STOP command (issued by calling **`TagEmulationStopRam()`** function), or by reader reset. Use the function GetReaderStatus to check if the reader is still in emulation mode (maybe the reader was reset for some reason).

Function declaration (C language)

```
UFR_STATUS TagEmulationStartRam(void);
```

TagEmulationStopRam

From library version 5.0.31, and firmware version 5.0.33

Function description

Allows the reader permanent exit from a NDEF tag emulation mode.

Function declaration (C language)

```
UFR_STATUS TagEmulationStopRam(void);
```

TagEmulationMirrorCounterResetEnabled

From library version 5.0.60, and firmware version 5.0.61.

Function description

Function enables the 24 bit NFC counter. Counter increased by the first valid READ command in the NTAG emulation mode, after the external RF field detected. Counter is represented in 6 bytes of ASCII code, when the NDEF message is read. For example if the counter value is 0x56, it will be represented as 000056, at the end of the NDEF message. Position of the counter mirror start byte must be entered as a function parameter. This is the absolute position in the card emulation data array.

Counter value sets to 0.

Function declaration (C language)

```
UFR_STATUS TagEmulationMirrorCounterResetEnabled(uint16_t mirror_pos);
```

Parameters

mirror_pos	Position in the card emulation data array

TagEmulationMirrorCounterNonResetEnabled

From library version 5.0.60, and firmware version 5.0.61.

Function description

Function enables the 24 bit NFC counter. Counter increased by the first valid READ command in the NTAG emulation mode, after the external RF field detected. Counter is represented in 6 bytes of ASCII code, when the NDEF message is read. For example if the counter value is 0x56, it will be represented as 000056, at the end of the NDEF message. Position of the counter mirror start byte must be entered as a function parameter. This is the absolute position in the card emulation data array.

Counter value stays unchangeable.

Function declaration (C language)

```
UFR_STATUS TagEmulationMirrorCounterNonResetEnabled(uint16_t
mirror_pos);
```

Parameters

`mirror_pos`	Position in the card emulation data array

TagEmulationMirrorCounterDisabled

From library version 5.0.60, and firmware version 5.0.61.

Function description

Function disables the NFC counter in the card emulation mode.

Function declaration (C language)

```
UFR_STATUS TagEmulationMirrorCounterDisabled(void);
```

Functions for setting Reader baud rates for ISO 14443 – 4A cards

SetSpeedPermanently

Function declaration (C language)

```
UFR_STATUS SetSpeedPermanently(uint8_t tx_speed, uint8_t rx_speed);
```

Parameters

`tx_speed`	setup value for transmit speed
`rx_speed`	setup value for receive speed

Valid speed setup values are:

Const	***Configured speed***
0	106 kbps (default)
1	212 kbps
2	424 kbps

On some reader types maximum rx_speed is 212 kbps. If you try to set higher speed than is allowed, reader firmware will automatically set the maximum possible speed.

Possible error codes:

```
WRITE_VERIFICATION_ERROR = 0x70
```

(command resulting in a direct write to a device non-volatile memory)

GetSpeedParameters

Function declaration (C language)

```
UFR_STATUS GetSpeedParameters(uint8_t* tx_speed, uint8_t* rx_speed);
```

Parameters

`tx_speed`	returns configured value for transmit speed
`rx_speed`	returns configured value for receive speed

FUNCTIONS FOR DISPLAY CONTROL

SetDisplayData

Function description

Function enables sending data to the display. A string of data contains information about the intensity of color in each cell of the display. Each cell has three LED (red, green and blue). For each cell of the three bytes is necessary. The first byte indicates the intensity of the green color, the second byte indicates the intensity of the red color, and the third byte indicates the intensity of blue color. For example, if the display has 16 cells, an array contains 48 bytes. Value of intensity is in range from 0 to 255.

Function declaration (C language)

```
UFR_STATUS SetDisplayData(uint8_t  *display_data,
                          uint8_t data_length);
```

Parameters

`display_data`	pointer to data array
`data_length`	number of data into array

SetSpeakerFrequency

Function description

Function sets the frequency of the speaker. The speaker is working on this frequency until a new frequency setting. To stop the operation set frequency to zero.

Function declaration (C language)

```
UFR_STATUS SetSpeakerFrequency(uint16_t frequency);
```

Parameter

`frequency`	frequency in Hz

FUNCTIONS TO USE THE SHARED RAM INTO DEVICE

Shared RAM is memory space on a device that is used for communication between computer and Android device (phone, tablet) with an NFC reader. PC writes and read data from shared RAM via USB port. Device with Android OS writes and read data from shared RAM via NFC.

EnterShareRamCommMode

Function description

Put reader permanently in the mode that use shared RAM. After execution of this function, must be executed function TagEmulationStart.

Function declaration (C language)

```
UFR_STATUS EnterShareRamCommMode(void);
```

ExitShareRamCommMode

Function description

The permanent exit from mode that use shared RAM. After execution of this function, must be executed function TagEmulationStop.

Function declaration (C language)

```
UFR_STATUS EnterShareRamCommMode(void);
```

WriteShareRam

Function description

Function allows writing data to the shared RAM.

Function declaration (C language)

```
UFR_STATUS WriteShareRam(uint8_t *ram_data,
                         uint8_t addr,
                         uint8_t data_len);
```

Parameters

`ram_data`	pointer to data array
`addr`	address of first data in an array
`data_len`	*l*ength of array. Address + data_len <= 184

ReadShareRam

Function description

Function allows read data from the shared RAM.

Function declaration (C language)

```
UFR_STATUS ReadShareRam(uint8_t *ram_data,
                         uint8_t addr,
                         uint8_t data_len);
```

Functions supporting Ad-Hoc emulation mode

This mode enables user controlled emulation from the user application. There is an “nfc-rfid-reader-sdk/ufr-examples-ad_hoc_emulation-c” console example written in C, which demonstrates usage of this function.

AdHocEmulationStart

Function description

Put uFR in emulation mode with ad-hoc emulation parameters (see. SetAdHocEmulationParams() and GetAdHocEmulationParams() functions). uFR stays in ad-hoc emulation mode until AdHocEmulationStop() is called or reader reset.

Function declaration (C language)

```
UFR_STATUS AdHocEmulationStart(void);
```

AdHocEmulationStop

Function description

Terminate uFR ad-hoc emulation mode.

Function declaration (C language)

```
UFR_STATUS AdHocEmulationStop(void);
```

GetExternalFieldState

Function description

Returns external field state when uFR is in ad-hoc emulation mode.

Function declaration (C language)

```
UFR_STATUS GetExternalFieldState(uint8_t *is_field_present);
```

is_field_present contains 0 if external field isn’t present or 1 if field is present.

GetAdHocEmulationParams

Function description

This function returns current ad-hoc emulation parameters. On uFR power on or reset ad-hoc emulation parameters are set back to their default values.

Function declaration (C language)

```
UFR_STATUS GetAdHocEmulationParams(uint8_t *ThresholdMinLevel,
                                   uint8_t *ThresholdCollLevel,
                                   uint8_t *RFLevelAmp,
                                   uint8_t *RxGain,
                                   uint8_t *RFLevel);
```

Parameters

ThresholdMinLevel	default value is 15. Could be in range from 0 to 15
ThresholdCollLevel	default value is 7. Could be in range from 0 to 7
RFLevelAmp	default value is 0. On uFR device should be 0 all the time. (1 for on, 0 for off).
RxGain	Could be in range from 0 to 7.
RFLevel	Could be in range from 0 to 15

SetAdHocEmulationParams

Function description

This command set ad-hoc emulation parameters. On uFR power on or reset ad-hoc emulation parameters are set back to their default values.

Function declaration (C language)

```
UFR_STATUS SetAdHocEmulationParams(uint8_t ThresholdMinLevel,
                                   uint8_t ThresholdCollLevel,
                                   uint8_t RFLevelAmp,
                                   uint8_t RxGain,
                                   uint8_t RFLevel);
```

Parameters

ThresholdMinLevel	default value is 15. Could be in range from 0 to 15
ThresholdCollLevel	default value is 7. Could be in range from 0 to 7
RFLevelAmp	default value is 0. On uFR device should be 0 all the time. (1 for on, 0 for off).
RxGain	Could be in range from 0 to 7.
RFLevel	Could be in range from 0 to 15

CombinedModeEmulationStart

Function description

Puts the uFR reader into a permanently periodical switching from “NDEF tag emulation mode” to “tag reader mode”. Only way for a reader to exit from this mode is to receive the TAG_EMULATION_STOP command (issued by calling the TagEmulationStop() function).

Much better control of the NFC device in a uFR proximity range can be achieved using Ad-Hoc emulation mode, described before.

Function declaration (C language)

```
UFR_STATUS CombinedModeEmulationStart(void);
```

Function takes no parameters.

Support for ISO14443-4 protocol

The protocol defines three fundamental types of blocks:

- I-block used to convey information for use by the application layer.

- R-block used to convey positive or negative acknowledgements. An R-block never contains an INF field. The acknowledgement relates to the last received block.

- S-block used to exchange control information between the PCD and the PICC. There is two different types of S-blocks:

1) Waiting time extension containing a 1 byte long INF field and

2) DESELECT containing no INF field.

Function declaration (C language)

```
UFR_STATUS i_block_trans_rcv_chain(uint8_t chaining,
                                   uint8_t timeout,
                                   uint8_t block_length,
                                   uint8_t *snd_data_array,
                                   uint8_t *rcv_length,
                                   uint8_t *rcv_data_array,
                                   uint8_t *rcv_chained,
                                   uint32_t *ufr_status);
```

Parameters

chaining	1 – chaining in use, 0 – no chaining
timeout	timeout for card reply
block_length	inf block length
snd_data_array	pointer to array of data that will be send
rcv_length	length of received data
rcv_data_array	pointer to array of data that will be received
rcv_chained	1 received packet is chained, 0 received packet is not chained
ufr_status	card operation status

Function declaration (C language)

```
UFR_STATUS r_block_transceive(uint8_t ack,
                              uint8_t timeout,
                              uint8_t *rcv_length,
                              uint8_t *rcv_data_array,
                              uint8_t *rcv_chained,
                              uint32_t *ufr_status);
```

Parameters

`ack`	1 ACK, 0 NOT ACK
`timeout`	timeout for card reply
`rcv_length`	length of received data
`rcv_data_array`	pointer to array of data that will be received
`rcv_chained`	1 received packet is chained, 0 received packet is not chained
`ufr_status`	card operation status

Function declaration (C language)

```
UFR_STATUS s_block_deselect(uint8_t timeout);
```

Parameter

`timeout`	timeout in [ms]

Support for APDU commands in ISO 14443-4 tags

Some ISO 14443-4 tags supports the APDU message structure according to ISO/IEC 7816-4.

For more details you have to check the manual for the tags that you are planning to use.

Function declarations used to support APDU message structure:

```
UFR_STATUS SetISO14443_4_Mode(void);

UFR_STATUS SetISO14443_4_Mode_GetATS(uint8_t ats[MAX_ATS_LEN],
                                     uint8_t *ats_len,
                                     uint8_t uid[MAX_UID_LEN],
                                     uint8_t *uid_len,
                                     uint8_t *sak);
```

Parameters

ats	After successful function execution, buffer on which this pointer points to will contain ATS returned from the TAG (historical bytes included). Before calling this function, you have to allocate MAX_ATS_LEN bytes for the ats buffer. MAX_ATS_LEN macro is defined in uFCoder.h (#define MAX_ATS_LEN 25).
ats_len	After successful function execution, variable on which this pointer points to will contain actual ATS length.
uid	After successful call to this function, buffer on which this pointer points to will contain TAG UID. Before calling this function, you have to allocate MAX_UID_LEN bytes for the ats buffer. MAX_UID_LEN macro is defined in uFCoder.h (#define MAX_UID_LEN 10).
uid_len	After successful function execution, variable on which this pointer points to will contain actual UID length.
sak	After successful function execution, variable on which this pointer points to will contain SAK (Select Acknowledge) of the TAG in field.

```
UFR_STATUS uFR_APDU_Transceive(uint8_t cls,
                               uint8_t ins,
                               uint8_t p0,
                               uint8_t p1,
                               uint8_t *data_out,
                               uint8_t data_out_len,
                               uint8_t *data_in,
                               uint32_t max_data_in_len,
                               uint32_t *response_len,
                               uint8_t send_le,
                               uint8_t *apdu_status);

UFR_STATUS s_block_deselect(uint8_t timeout);
```

Parameters

`cls`	APDU CLA (class byte)
`ins`	APDU command code (instruction byte)
`p0`	parameter byte
`p1`	parameter byte
`data_out`	APDU command data field. Use NULL if data_out_len is 0
`data_out_len`	number of bytes in the APDU command data field (Lc field)
`data_in`	buffer for receiving APDU response. There should be allocated at least (send_le + 2) bytes before function call.
`max_data_in_len`	size of the receiving buffer. If the APDU response exceeded size of buffer, then function returns error
`response_len`	value of the Le fied if send_le is not 0. After successful execution location pointed by the response_len will contain number of bytes in the APDU response.
`send_le`	if this parameter is 0 then APDU Le field will not be sent. Otherwise Le field will be included in the APDU message. Value response_len pointed to, before function call will be value of the Le field.
`apdu_status`	APDU error codes SW1 and SW2 in 2 bytes array

To send APDU message you must comply with the following procedure:

1. Call SetISO14443_4_Mode() or SetISO14443_4_Mode_GetATS(). ISO 14443-4 tag in a field will be selected and RF field polling will be stopped.

2. Call uFR_APDU_Transceive() as many times as you needed.
3. Call s_block_deselect() to deselect tag and restore RF field polling. This call is mandatory.

Fully uFR firmware support for APDU commands in ISO 14443-4 tags

Fully Extended APDU support is implemented in the uFCoder library from version 5.0.57 and uFR Plus firmware from version 5.0.57.

This group of newly designed functions makes use of the **uFR_APDU_Transceive()** obsolete. However, **uFR_APDU_Transceive()** function is still part of the uFCoder library for backward compatibility.

New functions implemented in the uFCoder library are:

```
UFR_STATUS APDUHexStrTransceive(const char *c_apdu, char **r_apdu);
UFR_STATUS APDUPlainTransceive(const uint8_t *c_apdu,
                               uint32_t c_apdu_len,
                               uint8_t *r_apdu,
                               uint32_t *r_apdu_len);
UFR_STATUS APDUTransceive(uint8_t cls,
                          uint8_t ins,
                          uint8_t p0,
                          uint8_t p1,
                          const uint8_t *data_out,
                          uint32_t Nc,
                          uint8_t *data_in,
                          uint32_t *Ne,
                          uint8_t send_le,
                          uint8_t *apdu_status);
```

These functions are more responsive than obsolete **uFR_APDU_Transceive()**, because most of the work if performed by a uFR firmware.

```
UFR_STATUS APDUHexStrTransceive(const char *c_apdu, char **r_apdu);
```

Using this function, you can send C–APDU in the c_string (zero terminated) containing pairs of the hexadecimal digits. Pairs of the hexadecimal digits can be delimited by any of the punctuation characters or white space.

****r_apdu** returns pointer to the c_string (zero terminated) containing pairs of the hexadecimal digits without delimiters.

```
UFR_STATUS APDUPlainTransceive(const uint8_t *c_apdu,
                               uint32_t c_apdu_len,
                               uint8_t *r_apdu,
                               uint32_t *r_apdu_len);
```

This is binary alternative function to the **`APDUHexStrTransceive()`**. C-APDU and R-APDU are sent and receive in the form of the byte arrays. There is obvious need for a **c_apdu_len** and ***r_apdu_len** parameters which represents length of the ***c_apdu** and ***r_apdu** byte arrays, respectively.

The memory space on which ***r_apdu** points, have to be allocated before calling of the **APDUPlainTransceive()**. Number of the bytes allocated have to correspond to the N_e bytes, defined by the L_e field in the C–APDU plus 2 bytes for SW1 and SW2.

```
UFR_STATUS APDUTransceive(uint8_t cls,
                          uint8_t ins,
                          uint8_t p0,
                          uint8_t p1,
                          const uint8_t *data_out,
                          uint32_t Nc,
                          uint8_t *data_in,
                          uint32_t *Ne,
                          uint8_t send_le,
                          uint8_t *apdu_status);
```

This is “exploded binary” alternative function intended for support APDU commands in ISO 14443-4A tags. **APDUTransceive()** receives separated parameters which are an integral part of the C–APDU. There are parameters **cls**, **ins**, **p0**, **p1** of the **uint8_t** type.

N_c defines number of bytes in the byte array ***data_out** point to. N_c also defines the L_c field in the C–APDU. Maximum value for the N_c *is 255. If* $N_c > 0$ *then* $L_c = N_c$, otherwise L_c *is omitted and* ****data_out*** can be NULL.

send_le and $*N_e$ parameters defines L_c field in the C–APDU. If **send_le** is 1 then L_e field will be included in the C–APDU. If **send_le** is 0 then L_e field will be omitted from the C–APDU.

If $*N_e$ *== 256 then* $L_e = 0$*, otherwise* $L_e = *N_e$.

The memory space on which ***data_in**, have to be allocated before calling the **APDUPlainTransceive()**. Number of the bytes allocated have to correspond to the $*N_e$ bytes, defined by the L_e field in the C–APDU.

After successfully executed **APDUTransceive()**, ***data_in** will contain the R-APDU data field (body).

***apdu_status** will contain R-APDU trailer (SW1 and SW2 APDU status bytes).

For older uFR firmware / deprecated / library backward compatibility

UFR_STATUS uFR_DESFIRE_Start(void);

UFR_STATUS uFR_DESFIRE_Stop(void);

UFR_STATUS uFR_APDU_Start(void); // Alias for uFR_DESFIRE_Start()

UFR_STATUS uFR_APDU_Stop(void); // Alias for uFR_DESFIRE_Stop()

UFR_STATUS uFR_i_block_transceive(uint8_t chaining, uint8_t timeout, uint8_t block_length, uint8_t *snd_data_array, size_t *rcv_length, uint8_t *rcv_data_array, uint32_t *ufr_status);

Support for ISO7816 protocol

uFR PLUS devices with SAM option only.

The device communicates via ISO7816 UART with the smart card located into the mini smart card holder. Supports synchronous cards which do not use C4/C8.

open_ISO7816_interface

Function description

Function activates the smart card and returns an ATR (Answer To Reset) array of bytes from the smart card.

After the successfully executed function, the same APDU commands as for ISO14443-4 tags can be used, but not at the same time.

Note. This function is used for NXP SAM AV2 activation, and unlocking if SAM is locked.

Function declaration (C language)

```
UFR_STATUS open_ISO7816_interface(uint8_t *atr_data, uint8_t *atr_len);
```

Parameters

***atr_data**	pointer to array containing ATR
***atr_len**	pointer to ATR length variable

open_ISO7816_Generic

Function description

Function activates the smart card and returns an ATR (Answer To Reset) array of bytes from the smart card.

Function declaration (C language)

```
UFR_STATUS open_ISO7816_Generic(uint8_t *atr_data, uint8_t *atr_len);
```

Parameters

***atr_data**	pointer to array containing ATR
***atr_len**	pointer to ATR length variable

APDU_switch_to_ISO7816_interface

Function description

Function switches the use of APDU to ISO7816 interface. The smart card must be in the active state.

Function declaration (C language)

```
UFR_STATUS APDU_switch_to_ISO7816_interface(void);
```

close_ISO7816_interface_no_APDU

Function description

Function deactivates the smart card. APDU commands are not used.

Function declaration (C language)

```
UFR_STATUS close_ISO7816_interface_no_APDU(void);
```

close_ISO7816_interface_APDU_ISO14443_4

Function description

Function deactivates the smart card. APDU commands are used by ISO 14443-4 tags. Tag must already be in ISO 14443-4 mode.

Function declaration (C language)

```
UFR_STATUS close_ISO7816_interface_APDU_ISO14443_4(void);
```

APDU_switch_to_ISO14443_4_interface

Function description

Function switches the use APDU to ISO14443-4 tags. The smart card stays in active state. Tag must already be in ISO 14443-4 mode.

Function declaration (C language)

```
UFR_STATUS APDU_switch_to_ISO14443_4_interface(void);
```

APDU_switch_off_from_ISO7816_interface

Function description

APDU commands are not used. The smart card stays in active state.

Function declaration (C language)

```
UFR_STATUS APDU_switch_off_from_ISO7816_interface(void);
```

Support for NXP SAM (Secure Application Module)

Two types of NXP SAM are supported: T1AD2060, and T1AR1070.

Only uFR Classic CS with SAM reader with firmware version 5.100.xx working with SAM.

SAM_get_version_raw

Function description

Function returns manufacturing related data of the MIFARE SAM. For more information refer to NXP documentation.

Function declaration (C language)

```
UFR_STATUS SAM_get_version_raw(uint8_t *data, uint8_t *length);
```

Parameters

`*data`	pointer to array containing version data
`*length`	pointer to length variable

SAM_get_version

Function description

Function returns type of SAM, and 7 bytes UID.

Types of SAM are declared into structure:

```
typedef enum E_SAM_HW_VER {
      SAM_UNKNOWN_TYPE,
      SAM_T1AD2060_AV1_MODE ,
      SAM_T1AD2060_AV2_MODE,
      SAM_T1AR1070_AV1_MODE,
      SAM_T1AR1070_AV2_MODE
}SAM_HW_TYPE;
```

Function declaration (C language)

```
UFR_STATUS SAM_get_version(SAM_HW_TYPE *sam_type, uint8_t *sam_uid);
```

Parameters

`*sam_type`	pointer to SAM type variable
`*sam_uid`	pointer to array containing 7 bytes UID

SAM_get_key_entry_raw

Function description

Function allows reading the contents of the key entry specified in the parameter key_no. For more information refer to NXP documentation.

Function declaration (C language)

```
UFR_STATUS SAM_get_key_entry_raw(uint8_t key_no,
                                 uint8_t *key_entry,
                                 uint8_t *key_length,
                                 uint8_t *apdu_sw);
```

Parameters

key_no	key reference number (0 - 127)
***key_entry**	pointer to array containing key entry data
***key_length**	pointer to key entry length variable
***apdu_sw**	pointer to array containing SW1 and SW2 APDU status bytes

SAM_authenticate_host_AV2_plain

Function description

Function is used to run a mutual 3-pass authentication between the MIFARE SAM AV2 and PC. A host authentication is required to:

• Load or update keys into the MIFARE SAM AV2

• Activate the MIFARE SAM AV2 after reset (if configured accordingly in the configuration settings of master key key_no 00h)

The communication in this process is plain, so key will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS SAM_authenticate_host_AV2_plain(uint8_t *host_aes_key,
                                        uint8_t key_nr,
                                        uint8_t key_version,
                                        uint8_t *apdu_sw);
```

Parameters

***host_aes_key**	pointer to array containing 16 bytes AES key
key_nr	key reference number (0 - 127)
key_version	key version (0 - 255)
***apdu_sw**	pointer to array containing SW1 and SW2 APDU status bytes

SAM_change_key_entry_aes_AV2_plain_host_key

Function description

Function allows changing KST (Key Storage Table) containing 3 AES-128 keys, and their versions.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS SAM_change_key_entry_aes_AV2_plain_host_key(
                              uint8_t key_entry_no,
                              uint8_t *aes_key_ver_a,
                              uint8_t ver_a,
                              uint8_t *aes_key_ver_b,
                              uint8_t ver_b,
                              uint8_t *aes_key_ver_c,
                              uint8_t ver_c,
                              uint8_t key_no_CEK,
                              uint8_t key_v_CEK,
                              uint8_t ref_no_KUC,
                              uint8_t sam_lock_unlock,
                              uint8_t sam_auth_host,
                              uint8_t *apdu_sw);
```

Parameters

key_entry_no	key reference number (0 - 127)
***aes_key_ver_a**	pointer to array containing 16 bytes of first AES key
ver_a	key version of first key (0 - 255)
***aes_key_ver_b**	pointer to array containing 16 bytes of second AES key
ver_b	key version of second key (0 - 255)
***aes_key_ver_c**	pointer to array containing 16 bytes of third AES key
ver_c	key version of third key (0 - 255)
key_no_CEK	reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number)
key_v_CEK	version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version)
ref_no_KUC	reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF)
sam_lock_unlock	SAM lock/unlock ability. If key_entry_no = 0 (master key), then the SAM will be locked after power up or reset, and minimal set of commands will be available.
sam_auth_host	Host authentication ability. If key_entry_no = 0 (master key), then the authentication with host key is mandatory after power up or reset, in opposition minimal set of commands will be available.
***apdu_sw**	pointer to array containing SW1 and SW2 APDU status bytes

SAM_change_key_entry_mifare_AV2_plain_one_key

Function description

Function allows changing KST containing two Crypto 1 keys (KeyA and KeyB) for authentication to Mifare Classic or Mifare Plus card in SL1 mode.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS SAM_change_key_entry_mifare_AV2_plain_one_key(
                                     uint8_t key_entry_no,
                                     uint8_t *keyA,
                                     uint8_t *keyB,
                                     uint8_t key_no_CEK,
                                     uint8_t key_v_CEK,
                                     uint8_t ref_no_KUC,
                                     uint8_t *apdu_sw);
```

Parameters

`key_entry_no`	key reference number (1 - 127)
`*keyA`	pointer to array containing 6 bytes Crypto 1 key A
`*keyB`	pointer to array containing 6 bytes Crypto 1 key B
`key_no_CEK`	reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number)
`key_v_CEK`	version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version)
`ref_no_KUC`	reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF)
`*apdu_sw`	pointer to array containing SW1 and SW2 APDU status bytes

SAM_change_key_entry_AES_AV2_plain_one_key

Function description

Function allows changing KST containing AES key for authentication to Mifare Desfire or Mifare Plus card in SL3 mode.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS SAM_change_key_entry_AES_AV2_plain_one_key(
                              uint8_t key_entry_no,
                              uint8_t *key,
                              uint8_t key_no_CEK,
                              uint8_t key_v_CEK,
                              uint8_t ref_no_KUC,
                              uint8_t *apdu_sw);
```

Parameters

`key_entry_no`	key reference number (1 - 127)
`*key`	pointer to array containing 16 bytes of AES key
`key_no_CEK`	reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number)
`key_v_CEK`	version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version)
`ref_no_KUC`	reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF)
`*apdu_sw`	pointer to array containing SW1 and SW2 APDU status bytes

SAM_change_key_entry_3K3DES_AV2_plain_one_key

Function description

Function allows changing KST containing 3K3DES key for authentication to Mifare Desfire card.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS SAM_change_key_entry_3K3DES_AV2_plain_one_key(
                              uint8_t key_entry_no,
                              uint8_t *key,
                              uint8_t key_no_CEK,
                              uint8_t key_v_CEK,
                              uint8_t ref_no_KUC,
                              uint8_t *apdu_sw);
```

Parameters

key_entry_no	key reference number (1 - 127)
***key**	pointer to array containing 24 bytes of 3K3DES key
key_no_CEK	reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number)
key_v_CEK	version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version)
ref_no_KUC	reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF)
***apdu_sw**	pointer to array containing SW1 and SW2 APDU status bytes

SAM_change_key_entry_DES_AV2_plain_one_key

Function description

Function allows changing KST containing DES key for authentication to Mifare Desfire card.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS SAM_change_key_entry_DES_AV2_plain_one_key(
                              uint8_t key_entry_no,
                              uint8_t *key,
                              uint8_t key_no_CEK,
                              uint8_t key_v_CEK,
                              uint8_t ref_no_KUC,
                              uint8_t *apdu_sw);
```

Parameters

key_entry_no	key reference number (1 - 127)
***key**	pointer to array containing 8 bytes of DES key
key_no_CEK	reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number)
key_v_CEK	version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version)
ref_no_KUC	reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF)
***apdu_sw**	pointer to array containing SW1 and SW2 APDU status bytes

SAM_change_key_entry_2K3DES_ULC_AV2_plain_one_key

Function description

Function allows changing KST containing 2K3DES key for authentication to Ultralight C card.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS SAM_change_key_entry_2K3DES_ULC_AV2_plain_one_key(
                              uint8_t key_entry_no,
                              uint8_t *key,
                              uint8_t key_no_CEK,
                              uint8_t key_v_CEK,
                              uint8_t ref_no_KUC,
                              uint8_t *apdu_sw);
```

Parameters

`key_entry_no`	key reference number (1 - 127)
`*key`	pointer to array containing 16 bytes of 2K3DES key
`key_no_CEK`	reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number)
`key_v_CEK`	version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version)
`ref_no_KUC`	reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF)
`*apdu_sw`	pointer to array containing SW1 and SW2 APDU status bytes

SAM_change_key_entry_2K3DES_desfire_AV2_plain_one_key

Function description

Function allows changing KST containing 2K3DES key for authentication to Mifare Desfire card.

The communication in this process is plain, so keys will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS SAM_change_key_entry_2K3DES_desfire_AV2_plain_one_key(
                              uint8_t key_entry_no,
                              uint8_t *key,
                              uint8_t key_no_CEK,
                              uint8_t key_v_CEK,
                              uint8_t ref_no_KUC,
                              uint8_t *apdu_sw);
```

Parameters

key_entry_no	key reference number (1 - 127)
***key**	pointer to array containing 16 bytes of 2K3DES key
key_no_CEK	reference number of CEK (Change Entry Key). (future host authentication for change this KST must be with AES key with key_no_CEK key reference number)
key_v_CEK	version of CEK (future host authentication for change this KST must be with AES key with key_ver_CEK key version)
ref_no_KUC	reference number of KUC (Key Usage Counter) (not support jet, unlimited number of authentication ref_no_KUC = 0xFF)
***apdu_sw**	pointer to array containing SW1 and SW2 APDU status bytes

WriteSamUnlockKey

Function description

If master key has enabled lock/unlock parameter, then SAM unlock with key with lock/unlock ability is required. uFR reader tries to unlock SAM with key which stored into reader by this function. If internal reader keys locked, then they must be unlocked first, with function ReaderKeysUnlock.

The communication in this process is plain, so key will be exposed during function execution. Use this function in security environment (disconnect LAN).

Function declaration (C language)

```
UFR_STATUS DL_API WriteSamUnlockKey(uint8_t key_no,
                                    uint8_t key_ver,
                                    uint8_t *aes_key);
```

Parameters

key_no	key reference number (0 - 127)
key_ver	key version (0 - 255)
***aes_key**	pointer to array containing 16 bytes of AES key

Java Card Application (JCApp)

JCApp stands for Java Card Application. By the “Java Card” term we refer to a contactless or dual interface Java Cards. For now, we have supported two JCApps in our uFR Series NFC API. Those JCApps are DLSigner and DLStorage.

PIN codes implemented on the Java Card Applications

DLSigner JCApp has mandatory PIN codes implemented. DLStorage JCApp has optional PIN codes implemented.

PIN code is an abbreviation of "Personal Identification Number". JCApps that have PIN codes implemented, contain 2 different PIN codes. These are SO (Security Officer) PIN and User PIN code. The so-called "Security Officer" is actually a user who has administrative privileges for accessing security objects on the JCApps and rights to write files. SO PIN code should be different from the User PIN code.

"Security Officer" is required to be logged in to access the card in cases when it is necessary to change the PIN and PUK codes and to change files, keys and / or certificates. Logging in with an User PIN code is necessary to get the digital signature of a hashed data string.

PIN codes on the JCApps can have a minimum of 4 characters and a maximum of 8 characters. Here, under the character there is any alphanumeric (case sensitive) or any printable character. Printable characters mainly refer to punctuation marks on the standard keyboards. When changing PIN codes, it is not recommended the use of specific characters that can be found only on individual localized keypads, but only characters that are in ASCII standard and that exist on standard US English keyboards.

In all of the JCApps, the default SO PIN and User PIN codes are set initially, consisting of eight consecutive numerical characters '0' (zero) or "00000000". The maximum number of incorrect consecutive PIN codes entered is 5. If the number of incorrect successive attempts to enter the PIN code is exceeded, that PIN code is blocked. While the PIN code is not blocked, entering the correct PIN code resets the incorrectly entered PIN codes counter. The only way to unblock your PIN is to enter the correct PUK code. PUK is the abbreviation of "PIN Unlock Key". SO PUK code serves exclusively to unblock SO PIN code and user PUK to unblock user PIN code. In the case of 10 consecutive incorrectly entered PUK codes, the PUK code becomes unusable, and the functionality on which the blocked PIN code relates, remains blocked forever.

Common JCApp PIN functions

JCAppLogin

Function description

This function is used to login to the JCApp with an appropriate PIN code. Every time you deselect the JCApp tag either by calling s_block_deselect(), ReaderReset(), ReaderClose() or because of the loss of the NFC field, in order to communicate with the same tag you have to select JCApp and login again, using this function.

Every successful login resets the incorrectly entered PIN code counter for the PIN code specified by the SO parameter.

Function declaration (C language)

```
UFR_STATUS JCAppLogin(uint8_t SO, uint8_t *pin, uint8_t pinSize);
```

Parameters

`SO`	If this parameter has value 0 function will try to login as a **User**. If this parameter has a value different then 0, the function will try to login as a **Security Officer (SO)**.
`pin`	Pointer to the array of bytes which contains PIN code.
`pinSize`	Effective size of the array of bytes which contains PIN code.

JCAppGetPinTriesRemaining

Function description

This function is used to get how many of the unsuccessful login attempts remain before specified PIN or PUK code will be blocked.

This function have parameter of the type dl_sec_code_t which is defined as:

```
typedef enum {
     USER_PIN = 0,
     SO_PIN,
     USER_PUK,
     SO_PUK
} dl_sec_code_t;
```

This function does not require to be logged in with any of the PIN codes.

Function declaration (C language)

```
UFR_STATUS JCAppGetPinTriesRemaining(dl_sec_code_t secureCodeType,
                                     uint16_t *triesRemaining);
```

Parameters

secureCodeType	Specifies the PIN code type (see the dl_sec_code_t type definition above, in the text)
triesRemaining	Pointer to the 16-bit unsigned integer which will contain the number of the unsuccessful login attempts remains before specified PIN code will be blocked, in case of successful function execution. If this value is 0 then the specified PIN code is blocked.

JCAppPinChange

Function description

This function is used to change the PIN or PUK code which type is specified with secureCodeType parameter of type dl_sec_code_t which is defined as:

```
typedef enum {
     USER_PIN = 0,
     SO_PIN,
     USER_PUK,
     SO_PUK
} dl_sec_code_t;
```

Prior to calling this function you have to be logged in with an SO PIN code.

Function declaration (C language)

```
UFR_STATUS JCAppPinChange(dl_sec_code_t secureCodeType,
                          uint8_t *newPin,
                          uint8_t newPinSize);
```

Parameters

secureCodeType	Specifies the PIN or PUK code type you wish to change (see the dl_sec_code_t type definition above, in the text)
newPin	Pointer to the array of bytes which contains a new code.
newPinSize	Effective size of the array of bytes which contains a new code.

JCAppPinUnblock

Function description

This function is used to unblock PIN code which is specified by the `SO parameter.`

This function does not require to be logged in with any of the PIN codes.

Function declaration (C language)

```
UFR_STATUS JCAppPinUnblock(uint8_t SO, uint8_t *puk, uint8_t pukSize);
```

`Parameters`

`SO`	If this parameter has value 0 function will try to unblock **User PIN** code. If this parameter has a value different then 0, the function will try to unblock **SO PIN** code.
`puk`	Pointer to the array of bytes which contains PUK code.
`pukSize`	Effective size of the array of bytes which contains PUK code.

PKI infrastructure and digital signature support

Fully supported from library version 4.3.8 and firmware version 3.9.55

In our product range, we have special cards called DLSigner JCApp, which contains support for PKI infrastructure and digital signing. To invoke API functions that support these features, the following conditions must be met:

1. The DLSigner JCApp card must be in the uFR reader field.
2. NFC tag must be in ISO 14443-4 mode. For entering ISO 14443-4 mode use the SetISO14443_4_Mode**()** or **SetISO14443_4_Mode_GetATS()** function.
3. Now you can call any of the API functions with the prefix “JCApp” as much as necessary.
4. At the end of the JCApp session it is necessary to call **s_block_deselect()** to deselect tag and restore RF field polling.

To generate digital signatures using DLSigner JCApp you need to have at least one of the private keys stored in a card. Further, if your data for signing have more than 255 bytes, you have to split them into the chunks and send them to a card using JCAppSignatureBegin() for the first chunk and JCAppSignatureUpdate() for the rest of the chunks. To generate a signature, you have to call JCAppSignatureEnd() after you have sent all of the data for signing. Finally, to get a signature, you have to call JCAppGetSignature().

If your data for signing have 255 bytes or less, it is sufficient to call JCAppGenerateSignature() only once and immediately after that call JCAppGetSignature() to get a signature.

DLSigner requires usage of the SO (security officer) PIN and User PIN codes. More about DLSigner you can find in a document “uFR digital signing and verification tools”.

JCAppSelectByAid

Function description

Using this function you can select the appropriate application on the card. For the DLSigner JCApp AID should be 'F0 44 4C 6F 67 69 63 00 01'. For the DLStorage JCApp AID should be 'F0 44 4C 6F 67 69 63 01 01'. Before calling this function, the NFC tag must be in ISO 14443-4 mode. For entering ISO 14443-4 mode use the SetISO14443_4_Mode() or

SetISO14443_4_Mode_GetATS() function.

Function declaration (C language)

```
UFR_STATUS JCAppSelectByAid(const uint8_t *aid,
                            uint8_t aid_len,
                            uint8_t selection_response[16]);
```

Parameters

`aid`	Pointer to array containing AID (Application ID) i.e: "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01" for the DLSigner or "\xF0\x44\x4C\x6F\x67\x69\x63\x01\x01" for the DLStorage JCApp.
`aid_len`	Length of the AID in bytes (9 for the DLSigner or DLStorage JCApps).
`selection_response`	On Application successful selection, the card returns 16 bytes. In the current version only the first of those bytes (i.e. byte with index 0) is relevant and contains JCApp card type which is 0xA0 for actual revision.

JCAppPutPrivateKey

Function description

In JCApp cards you can put two types of asymmetric crypto keys. Those are RSA and ECDSA private keys, three of each. Before you can use a JCApp card for digital signing you have to put an appropriate private key in it. There is no way to read out private keys from the card.

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

This feature is disabled in the regular DLSigner JCApp. To acquire cards with this feature enabled you have to contact your supplier with a special request.

Prior to calling this function you have to be logged in with an SO PIN code.

Function declaration (C language)

```
UFR_STATUS JCAppPutPrivateKey(uint8_t key_type,
                              uint8_t key_index,
                              const uint8_t *key,
                              uint16_t key_bit_len,
                              const uint8_t *key_param,
                              uint16_t key_parm_len);
```

Parameters

key_type	0 for RSA private key and 1 for ECDSA private key.
key_index	For each of the card types there are 3 different private keys that you can set. Their indexes are from 0 to 2.
key	Pointer to array containing key bytes.
key_bit_len	Key **length in bits**.
key_param	Reserved for future use (RFU). Use null for this parameter.
key_parm_len	Reserved for future use (RFU). Use 0 for this parameter.

JCAppSignatureBegin

Function description

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Function declaration (C language)

```
UFR_STATUS JCAppSignatureBegin(uint8_t cipher,
                               uint8_t digest,
                               uint8_t padding,
                               uint8_t key_index,
                               const uint8_t *chunk,
                               uint16_t chunk_len,
                               const uint8_t *alg_param,
                               uint16_t alg_parm_len);
```

Parameters

cipher	0 for the RSA private key and 1 for the ECDSA.
digest	0 for none digest (not supported with ECDSA) and 1 for SHA1
padding	0 for none (not supported with RSA) and 1 for pads the digest according to the PKCS#1 (v1.5) scheme.
key_index	For each of the card types there are 3 different private keys that you can set. Their indexes are from 0 to 2.
chunk	Pointer to array containing first chunk of data.
chunk_len	Length of the first chunk of data (max. 255).
alg_param	Reserved for future use (RFU). Use null for this parameter.
alg_parm_len	Reserved for future use (RFU). Use 0 for this parameter.

JCAppSignatureUpdate

Function description

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Function declaration (C language)

```
UFR_STATUS JCAppSignatureUpdate(const uint8_t *chunk,
                                uint16_t chunk_len);
```

Parameters

chunk	Pointer to an array containing one of the chunks of data.
chunk_len	Length of the current one of the remaining chunks of data (max. 255).

JCAppSignatureEnd

Function description

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Function declaration (C language)

```
UFR_STATUS JCAppSignatureEnd(uint16_t *sig_len);
```

Parameters

`sig_len`	Pointer to a 16-bit value in which you will get length of the signature in case of a successful executed chain of function calls, described in the introduction of this topic.

JCAppGenerateSignature

Function description

This function virtually combines three successive calls of functions JCAppSignatureBegin(), JCAppSignatureUpdate() and JCAppSignatureEnd() and can be used in case your data for signing have 255 bytes or less.

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Prior to calling this function you have to be logged in with a User PIN code.

Function declaration (C language)

```
UFR_STATUS JCAppGenerateSignature(uint8_t cipher,
                                  uint8_t digest,
                                  uint8_t padding,
                                  uint8_t key_index,
                                  const uint8_t *plain_data,
                                  uint16_t plain_data_len,
                                  uint16_t *sig_len,
                                  const uint8_t *alg_param,
                                  uint16_t alg_parm_len);
```

Parameters

`cipher`	0 for the RSA private key and 1 for the ECDSA.
`digest`	0 for none digest (not supported with ECDSA) and 1 for SHA1
`padding`	0 for none (not supported with RSA) and 1 for pads the digest according to the PKCS#1 (v1.5) scheme.
`key_index`	For each of the card types there are 3 different private keys that you can set. Their indexes are from 0 to 2.
`plain_data`	Pointer to array containing data for signing.
`plain_data_len`	Length of the data for signing (max. 255).
`sig_len`	Pointer to a 16-bit value in which you will get the length of the signature in case of successful execution.
`alg_param`	Reserved for future use (RFU). Use null for this parameter.
`alg_parm_len`	Reserved for future use (RFU). Use 0 for this parameter.

JCAppGetSignature

Function description

Finally, to get a signature, you have to call JCAppGetSignature().

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Prior calling of this function you have to be logged in with an User PIN code.

Function declaration (C language)

```
UFR_STATUS JCAppGetSignature(uint8_t *sig,
                             uint16_t sig_len);
```

Parameters

`sig`	Pointer to an array of “sig_len” bytes length. Value of the “sig_len” you've got as a parameter of the JCAppSignatureEnd() or JCAppGenerateSignature() functions. You have to allocate those bytes before calling this function.
`sig_len`	Length of the allocated bytes in a sig array.

JCAppPutObj

Function description

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Prior to calling this function you have to be logged in with an SO PIN code.

Function declaration (C language)

```
UFR_STATUS JCAppPutObj(uint8_t obj_type,
                       uint8_t obj_index,
                       uint8_t *obj,
                       int16_t obj_size,
                       uint8_t *id,
                       uint8_t id_size);
```

Parameters

`obj_type`	0 for certificate containing RSA public key, 1 for certificate containing ECDSA public key and 2 for the CA (certificate authority).
`obj_index`	For each of the certificates containing RSA or ECDSA public keys there are 3 different corresponding private keys that should be set before placing the certificates themselves. Their indexes are from 0 to 2. For CA there are 12 memory slots so their indexes can be from 0 to 11.
`obj`	Pointer to an array containing an object (certificate).
`obj_size`	Length of the object (certificate).
`id`	Pointer to an array containing **object id**. Object id is a symbolic value and has to be unique on the card.
`id_size`	Length of the **object id**. Minimum object id length can be 1 and maximum 253.

JCAppPutObjSubject

Function description

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Prior to calling of this function you have to be logged in with an SO PIN code.

Function declaration (C language)

```
UFR_STATUS JCAppPutObjSubject(uint8_t obj_type,
                              uint8_t obj_index,
                              uint8_t *subject,
                              uint8_t size);
```

Parameters

obj_type	0 for certificate containing RSA public key, 1 for certificate containing ECDSA public key and 2 for the CA (certificate authority).
obj_index	For each of the certificates containing RSA or ECDSA public keys there are 3 different corresponding private keys that should be set before placing the certificates themselves. Their indexes are from 0 to 2. For CA there are 12 memory slots so their indexes can be from 0 to 11.
subject	Pointer to an array containing subject. Subject is a symbolic value linked to an appropriate certificate by the same obj_type and index.
size	Length of the subject. Maximum subject length is 255.

JCAppInvalidateCert

Function description

Using this function you can delete certificate objects from a card. This includes subjects linked to a certificate.

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

Prior to calling this function you have to be logged in with an SO PIN code.

Function declaration (C language)

```
UFR_STATUS JCAppInvalidateCert(uint8_t obj_type,
                               uint8_t obj_index);
```

Parameters

obj_type	0 for certificate containing RSA public key, 1 for certificate containing ECDSA public key and 2 for the CA (certificate authority).
obj_index	For each of the certificates containing RSA or ECDSA public keys there are 3 different corresponding private keys that should be set before placing the certificates themselves. Their indexes are from 0 to 2. For CA there are 12 memory slots so their indexes can be from 0 to 11.

JCAppGetObjId

Function description

This function you always have to call 2 times. Before the first call you have to set parameter ***id*** to **null** and you will get the id_size of the obj_type at obj_index. Before the second call you have to allocate an array of the returned ***id_size*** bytes and pass that array using parameter ***id***. Before second call, ***id_size*** should be set to a value of the exact bytes allocated.

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

This function does not require to be logged in with any of the PIN codes.

Function declaration (C language)

```
UFR_STATUS JCAppGetObjId(uint8_t obj_type,
                         uint8_t obj_index,
                         uint8_t *id,
                         uint16_t *id_size);
```

Parameters

obj_type	0 for certificate containing RSA public key, 1 for certificate containing ECDSA public key and 2 for the CA (certificate authority).
obj_index	For each of the certificates containing RSA or ECDSA public keys there are 3 different corresponding private keys that should be set before placing the certificates themselves. Their indexes are from 0 to 2. For CA there are 12 memory slots so their indexes can be from 0 to 11.
id	When id == NULL, the function returns id_size.
id_size	Before second call, *id_size should be set to a value of the exact bytes allocated.

JCAppGetObjSubject

Function description

This function you always have to call 2 times. Before the first call you have to set the parameter ***subject*** to **null** and you will get the size of the obj_type at obj_index. Before the second call you have to allocate an array of returned ***size*** bytes and pass that array using parameter ***subject***. Before second call, ****size*** should be set to a value of the exact bytes allocated.

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

This function does not require to be logged in with any of the PIN codes.

Function declaration (C language)

```
UFR_STATUS JCAppGetObjSubject(uint8_t obj_type,
                              uint8_t obj_index,
                              uint8_t *subject,
                              uint16_t *size);
```

Parameters

`obj_type`	0 for certificate containing RSA public key, 1 for certificate containing ECDSA public key and 2 for the CA (certificate authority).
`obj_index`	For each of the certificates containing RSA or ECDSA public keys there are 3 different corresponding private keys that should be set before placing the certificates themselves. Their indexes are from 0 to 2. For CA there are 12 memory slots so their indexes can be from 0 to 11.
`subject`	When subject == NULL, function returns size.
`size`	Before second call, *size should be set to a value of the exact bytes allocated.

JCAppGetObj

Function description

This function you always have to call 2 times. Before the first call you have to set parameter ***obj*** to **null** and you will get the size of the obj_type at obj_index. Before the second call you have to allocate an array of returned ***size*** bytes and pass that array using parameter ***obj***. Before second call, ****size*** should be set to a value of the exact bytes allocated.

Before calling this function, NFC tag must be in ISO 14443-4 mode and JCApp should be selected using JCAppSelectByAid() with AID = "\xF0\x44\x4C\x6F\x67\x69\x63\x00\x01".

This function does not require to be logged in with any of the PIN codes.

Function declaration (C language)

```
UFR_STATUS JCAppGetObj(uint8_t obj_type,
                       uint8_t obj_index,
                       uint8_t *obj,
                       int16_t size);
```

Parameters

obj_type	0 for certificate containing RSA public key, 1 for certificate containing ECDSA public key and 2 for the CA (certificate authority).
obj_index	For each of the certificates containing RSA or ECDSA public keys there are 3 different corresponding private keys that should be set before placing the certificates themselves. Their indexes are from 0 to 2. For CA there are 12 memory slots so their indexes can be from 0 to 11.
obj	When obj == NULL, function returns size.
size	Before second call, *size should be set to a value of the exact bytes allocated.

DLStorage JCApp support

Fully supported from library version 5.0.8 and firmware version 5.0.20

DLStorage supports up to 16 files on the card and each of those files can be up to 32 KB in size, limited by the overall size of the card. This JCApp supports fast reading mechanism utilizing Extended APDU case 2E and "water-level" PCD reading algorithm in the uFR firmware. For now there is one model - DLStorage 30 with 40 KB of storage size. With the DLStorage App you can optionally use two different PIN codes: one for writing operations and a different one for reading operations.

JCStorageGetFilesListSize

Function description

This function has to be called before JCStorageListFiles() to acquire the size of the array of bytes needed to be allocated for the list of currently existing files on the DLStorage card. Maximum files on the DLStorage card is 16.

Function declaration (C language)

```
UFR_STATUS JCStorageGetFilesListSize(uint32_t *list_size);
```

Parameters

`list_size`	Pointer to the 32-bit unsigned integer which will contain the size of the array of bytes needed to be allocated prior to calling the JCStorageListFiles() function.

JCStorageListFiles

Function description

After calling the JCStorageGetFilesListSize() function and getting the size of the list of the currently existing files on the DLStorage card, and if the list size is greater than 0, you can allocate a convenient array of bytes and then call this function. On successful function execution, the array pointed by the list parameter will contain indexes of the existing files on the card. Maximum files on the DLStorage card is 16. Each byte of the array pointed by the list parameter contains a single index of the existing file on the DLStorage card.

Function declaration (C language)

```
UFR_STATUS JCStorageListFiles(uint8_t *list,
                              uint32_t list_bytes_allocated);
```

Parameters

`list`	Pointer to the allocated array of bytes of the size acquired by the previous call to JCStorageGetFilesListSize() function.
`list_bytes_allocated`	Size of the array of bytes pointed by the list parameter. Have to be equal to the value of the *list_size acquired by the previous call to JCStorageGetFilesListSize() function.

JCStorageGetFileSize

Function description

This function returns file size indexed by the parameter card_file_index, on successful execution. Returned file size is in bytes. Maximum files on the DLStorage card is 16 and file indexes are zero-based so indexes can be in the range of 0 to 15. You have to know file size to allocate an appropriate amount of data prior to calling the JCStorageReadFile() function.

Function declaration (C language)

```
UFR_STATUS JCStorageGetFileSize(uint8_t card_file_index,
                                uint32_t *file_size);
```

Parameters

card_file_index	It should contain an index of the file which size we want to get.
file_size	Pointer to the 32-bit unsigned integer which will contain size in bytes of the file having card_file_index.

JCStorageReadFile

Function description

After calling the JCStorageGetFileSize() function and getting the size of the file on the DLStorage card you can allocate a convenient array of bytes and then call this function. On successful function execution, the array pointed by the data parameter will contain file content. If the file with the index defined by the card_file_index parameter does not exist, the function will return UFR_APDU_SW_FILE_NOT_FOUND (0x000A6A82) error code. Maximum files on the DLStorage card is 16 and file indexes are zero-based so indexes can be in the range of 0 to 15.

Function declaration (C language)

```
UFR_STATUS JCStorageReadFile(uint8_t card_file_index,
                             uint8_t *data,
                             uint32_t data_bytes_allocated);
```

Parameters

card_file_index	It should contain an index of the file we want to read.
data	Pointer to the allocated array of bytes of the size acquired by the previous call to JCStorageGetFileSize() function.
data_bytes_allocated	Size of the array of bytes pointed by the data parameter. Have to be equal to the value of the *file_size acquired by the prior calling JCStorageGetFileSize() function.

JCStorageReadFileToFileSystem

Function description

This function reads a file from the DLStorage card directly to the new file on the host file-system. If the file on the host file system already exists, it will be overwritten. If the file with the index defined by the card_file_index parameter does not exist, the function will return UFR_APDU_SW_FILE_NOT_FOUND (0x000A6A82) error code. Maximum files on the DLStorage card is 16 and file indexes are zero-based so indexes can be in the range of 0 to 15.

Function declaration (C language)

```
UFR_STATUS JCStorageReadFileToFileSystem(uint8_t card_file_index,
                                         const char *file_system_path_name);
```

Parameters

card_file_index	It should contain an index of the file we want to read.
file_system_path_name	Pointer to the null-terminated string that should contain path and the name of the new file on the host file-system which will contain the data read from the file on the card in case of successful function execution.

JCStorageWriteFile

Function description

This function creates a file on the DLStorage card and writes an array of bytes pointed by the data parameter to it. Parameter data_size defines the amount of data to be written in the file on the DLStorage card. If the file with the index defined by the card_file_index parameter already exists on the card, the function will return UFR_APDU_SW_ENTITY_ALREADY_EXISTS (0x000A6A89) error code. Maximum files on the DLStorage card is 16 and file indexes are zero-based so indexes can be in the range of 0 to 15. If there is an error during the writing procedure, for example because of the loss of the NFC field and the file is only partially written (tearing event), a corrupted file on the DLStorage card should be deleted and then written again. Therefore we suggest you to always do verification of the data written to the card.

Function declaration (C language)

```
UFR_STATUS JCStorageWriteFile(uint8_t card_file_index,
                              const uint8_t *data,
                              uint32_t data_size);
```

Parameters

card_file_index	It should contain an index of the file we want to create and write data to it.
data	Pointer to the data i.e. array of bytes to be written into the new file on the card.
data_size	Size, in bytes, of the data to be written into the file on the card.

JCStorageWriteFileFromFileSystem

Function description

This function writes file content from the host file-system to the new file on the DLStorage card. If the file with the index defined by the card_file_index parameter already exists on the card, the function will return UFR_APDU_SW_ENTITY_ALREADY_EXISTS (0x000A6A89) error code. Maximum files on the DLStorage card is 16 and file indexes are zero-based so indexes can be in the range of 0 to 15. If there is an error during the writing procedure, for example because of the loss of the NFC field and the file is only partially written (tearing event), a corrupted file on the DLStorage card should be deleted and then written again. Therefore we suggest you to always do verification of the data written to the card.

Function declaration (C language)

```
UFR_STATUS JCStorageWriteFileFromFileSystem(uint8_t card_file_index,
                                     const char *file_system_path_name);
```

Parameters

card_file_index	It should contain an index of the file on the card we want to create and write content of the file from the host file-sistem to it.
file_system_path_name	Pointer to the null-terminated string that should contain path and the name of the file from the host file-sistem whose content we want to transfer to the new file on the card.

JCStorageDeleteFile

Function description

After successful call to this function, the file on the DLStorage card will be deleted. Maximum files on the card is 16 and file indexes are zero-based so indexes can be in the range of 0 to 15. If a file with index defined by the file_index parameter does not exist, the function will return UFR_APDU_SW_FILE_NOT_FOUND (0x000A6A82) error code.

Function declaration (C language)

```
UFR_STATUS JCStorageDeleteFile(uint8_t file_index);
```

Parameters

file_index	It should contain an index of the file we want to delete.

General purpose cryptographic functions

DLGetHashName

Function description

This function returns pointer to a null terminated string constant which contains the name of the hash algorithm designated by the input function parameter.

Function declaration (C language)

```
c_string DLGetHashName(uint32_t hash_algo);
```

Parameters

hash_algo	Hash designator. Use values declared in E_HASH_ALGS enumeration.

DLGetEccCurveName

Function description

This function returns pointer to a null terminated string constant which contains the name of the ECC curve designated by the input function parameter.

Function declaration (C language)

```
c_string DLGetEccCurveName(uint32_t eccCurve);
```

Parameters

eccCurve	ECC curve designator. Use values declared in E_ECC_CURVES enumeration.

DLGetSignatureSchemeName

Function description

This function returns pointer to a null terminated string constant which contains the name of the signature scheme (signature algorithm) designated by the input function parameter.

Function declaration (C language)

```
c_string DLGetSignatureSchemeName(uint32_t signatureScheme);
```

Parameters

signatureScheme	Signature scheme (signature algorithm) designator. Use values declared in E_SIGNATURE_SCHEMES enumeration.

Cryptographic hashing algorithms

DLGetHashOutputByteLength

Function description

This function is used to get hash output length in bytes for specified hash algorithms.

Function declaration (C language)

```
UFR_STATUS DLGetHashOutputByteLength(uint32_t hash_algo,
                                     uint32_t *out_byte_len);
```

Parameters

`hash_algo`	Hash designator for which we want to get output length in bytes. Use values declared in E_HASH_ALGS enumeration.
`out_byte_len`	After successful function execution, the variable on which this pointer points to, will contain output hash length in bytes for specified hash algorithm.

DLGetHash

Function description

This function calculates and returns the hash of the data in the buffer pointed by the "**in**" function parameter. Hash algorithm is specified by the **hash_algo** function parameter.

If output bytes don't match with hash_alocated function parameter function returns CRYPTO_SUBSYS_WRONG_HASH_OUTPUT_LENGTH status.

Function declaration (C language)

```
UFR_STATUS DLGetHash(uint32_t hash_algo,
                     IN const uint8_t *in,
                     uint32_t in_len,
                     OUT uint8_t *hash,
                     uint32_t hash_alocated);
```

Parameters

`hash_algo`	Hash designator. Use values declared in E_HASH_ALGS enumeration.
`in`	Input buffer of which hash is calculated.
`in_len`	Input buffer length in bytes. Maximum buffer length is 32 KB. If you have more data, use the chunked hashing method (see usage instructions of the **`DLHashInitChunked()`**, **`DLHashUpdateChunked()`** and **`DLHashFinishChunked()`** functions).
`hash`	After successful function execution, the variable on which this pointer points to, will contain output hash.
`hash_alocated`	This parameter should contain the number of bytes previously allocated in the hash buffer. This parameter have to be greater or equal to the output length of the hash algorithm which is specified by the **`hash_algo`** parameter.

DLGetHashToHeap

Function description

This function calculates and returns the hash of the data in the buffer pointed by the "**in**" function parameter. Hash algorithm is specified by the **hash_algo** function parameter.

If output bytes don't match with hash_alocated function parameter function returns CRYPTO_SUBSYS_WRONG_HASH_OUTPUT_LENGTH status.

GetHashToHeap() automatically allocates memory, which *hash parameter will point to after successful execution. User is obligated to cleanup allocated memory space, occupied by the ***hash**, after use (e.g. by calling DLFree() or directly free() from the C/C++ code).

Function declaration (C language)

```
UFR_STATUS DLGetHashToHeap(uint32_t hash_algo,
                           const uint8_t *in,
                           uint32_t in_len,
                           uint8_t **hash,
                           uint32_t *hash_len);
```

Parameters

`hash_algo`	Hash designator which specifies the hash algorithm used for calculation. Use values declared in E_HASH_ALGS enumeration.
`in`	Input buffer of which hash is calculated.
`in_len`	Input buffer length in bytes. Maximum buffer length is 32 KB. If you have more data, use the chunked hashing method (see usage instructions of the **`DLHashInitChunked()`**, **`DLHashUpdateChunked()`** and **`DLHashFinishChunked()`** functions).
`hash`	After successful function execution, the variable on which this pointer points to, will contain the pointer to the output hash.
`hash_len`	After successful function execution, the variable on which this pointer points to, will contain output hash length.

DLHashInitChunked

Function description

This function is used in conjunction with **`DLHashUpdateChunked()`** and **`DLHashFinishChunked()`** or **`DLHashFinishChunkedToHeap()`** functions.

These functions have the same result as the single call to DLGetHash() or DLGetHashToHeap() functions but they are used for larger amounts of data to hash.

These functions have to be called in the specific sequence. Disruption of the calling sequence leads to unpredictable results. In every hashing sequence, DLHashInitChunked() has to be called exactly once, in the beginning of the sequence. After successful hashing sequence initialization, there can be as many as needed DLHashUpdateChunked() calls. Chunk sizes may vary throughout the sequence. At the end of the sequence there can be exactly one call to either DLHashFinishChunked() or DLHashFinishChunkedToHeap() function. These two functions differ only in that the DLHashFinishChunkedToHeap() automatically allocates space for a resulting hash while the DLHashFinishChunked() expects to store the result in an already allocated memory on the heap. Calling one of DLHashFinishChunked() or DLHashFinishChunkedToHeap() functions finishes the current hashing sequence.

Function declaration (C language)

```
UFR_STATUS DLHashInitChunked(uint32_t hash_algo);
```

Parameters

hash_algo	Hash designator which specifies the hash algorithm used in the following hashing sequence. Use values declared in E_HASH_ALGS enumeration.

DLHashUpdateChunked

Function description

This function is used in conjunction with **DLHashInitChunked()** and **DLHashFinishChunked()** or **DLHashFinishChunkedToHeap()** functions.

These functions have the same result as the single call to DLGetHash() or DLGetHashToHeap() functions but they are used for larger amounts of data to hash.

These functions have to be called in the specific sequence. Disruption of the calling sequence leads to unpredictable results. In every hashing sequence, DLHashInitChunked() have to be called exactly once, in the beginning of the sequence. After successful hashing sequence initialization, there can be as many as needed DLHashUpdateChunked() calls. Chunk sizes may vary throughout the sequence. At the end of the sequence there can be exactly one call to either DLHashFinishChunked() or DLHashFinishChunkedToHeap() function. These two functions differ only in that the DLHashFinishChunkedToHeap() automatically allocates space for a resulting hash while the DLHashFinishChunked() expects to store the result in an already allocated memory on the heap. Calling one of DLHashFinishChunked() or DLHashFinishChunkedToHeap() functions finishes current hashing sequence.

Function declaration (C language)

```
UFR_STATUS DLHashUpdateChunked(IN const uint8_t *in, uint32_t in_len);
```

Parameters

`in`	One of the chunks of data of which hash is calculated.
`in_len`	Chunk length in bytes.

DLHashFinishChunked

Function description

This function is used in conjunction with **`DLHashInitChunked()`** and **`DLHashUpdateChunked()`** functions.

These functions have the same result as the single call to DLGetHash() or DLGetHashToHeap() functions but they are used for larger amounts of data to hash.

These functions have to be called in the specific sequence. Disruption of the calling sequence leads to unpredictable results. In every hashing sequence, DLHashInitChunked() have to be called exactly once, in the beginning of the sequence. After successful hashing sequence initialization, there can be as many as needed DLHashUpdateChunked() calls. Chunk sizes may vary throughout the sequence. At the end of the sequence there can be exactly one call to either DLHashFinishChunked() or DLHashFinishChunkedToHeap() function. These two functions differ only in that the DLHashFinishChunkedToHeap() automatically allocates space for a resulting hash while the DLHashFinishChunked() expects to store the result in an already allocated memory on the heap. Calling one of DLHashFinishChunked() or DLHashFinishChunkedToHeap() functions finishes the current hashing sequence.

Function declaration (C language)

```
UFR_STATUS DLHashFinishChunked(OUT uint8_t *hash,
                               uint32_t hash_alocated);
```

Parameters

`hash`	After successful function execution, the variable on which this pointer points to, will contain output of the hashing sequence.
`hash_alocated`	This parameter should contain the number of bytes previously allocated in the hash buffer. This parameter have to be greater or equal to the output length of the hash algorithm which is specified by the **`hash_algo`** parameter passed in the previous call to the **`DLHashInitChunked()`**, in the beginning of the hashing sequence.

DLHashFinishChunkedToHeap

Function description

This function is used in conjunction with **`DLHashInitChunked()`** and **`DLHashUpdateChunked()`** functions.

These functions have the same result as the single call to DLGetHash() or DLGetHashToHeap() functions but they are used for larger amounts of data to hash.

These functions have to be called in the specific sequence. Disruption of the calling sequence leads to unpredictable results. In every hashing sequence, DLHashInitChunked() have to be called exactly once, in the beginning of the sequence. After successful hashing sequence initialization, there can be as many as needed DLHashUpdateChunked() calls. Chunk sizes may vary throughout the sequence. At the end of the sequence there can be exactly one call to either DLHashFinishChunked() or DLHashFinishChunkedToHeap() function. These two functions differ only in that the DLHashFinishChunkedToHeap() automatically allocates space for a resulting hash while the DLHashFinishChunked() expects to store the result in an already allocated memory on the heap. Calling one of DLHashFinishChunked() or DLHashFinishChunkedToHeap() functions finishes the current hashing sequence.

DLHashFinishChunkedToHeap() automatically allocates memory, which *hash parameter will point to, after successful execution. User is obligated to cleanup allocated memory space, occupied by the *hash, after use (e.g. by calling DLFree(cert) or directly free(cert) from the C/C++ code).

Function declaration (C language)

```
UFR_STATUS DLHashFinishChunkedToHeap(uint8_t **hash,
                                     uint32_t *hash_len);
```

Parameters

`hash`	After successful function execution, the variable on which this pointer points to, will contain the pointer to the output of the hashing sequence.
`hash_len`	After successful function execution, the variable on which this pointer points to, will contain output hash length.

DLFree

Function description

Release the memory allocated from some of the library functions previously called making it available again for further allocations. Use to deallocate i.e. cleanup memory on the heap allocated. This function is a so-called helper for programming languages other than C/C++ where you can use a free(ptr) instead. Use only after calling the library functions for which it is explicitly indicated in this manual. Function returns nothing. After successful function execution ptr will point to NULL.

Function declaration (C language)

```
void DLFree(void *ptr);
```

Parameters

ptr	Pointer to the memory allocated on the heap which you want to release. If ptr does not point to a block of memory allocated with the library functions, it causes undefined behavior. If ptr is NULL, the function does nothing.

Digital signature verification

Enumerations, types and structures for use with DigitalSignatureVerifyHash function

```
enum E_ECC_CURVE_DEFINITION_TYPES {
    ECC_CURVE_INDEX,
    ECC_CURVE_NAME,
    ECC_CURVE_DOMAIN_PARAMETERS,
    ECC_CURVE_DEFINITION_TYPES_NUM
};

typedef struct {
    uint32_t ecc_curve_field_type;
    void *field_domain_params;
} ecc_curve_domain_params_t;

typedef struct {
    uint32_t ecc_curve_definition_type;
    uint32_t ecc_curve_index;
    char *ecc_curve_name;
    ecc_curve_domain_params_t *ecc_curve_domain_params;
} ecc_key_param_t;
```

DigitalSignatureVerifyHash

Function description

This function is used to verify the digital signature of the pre-hashed value or some relatively short plain text message. If there is no errors during the verification process and digital signature correspond to the "To Be Signed" (TBS) data array and public cryptographic key, the function returns **UFR_OK** status. "To Be Signed" is just a colloquial term for already signed data, which is the origin of the digital signature.

In case of wrong digital signature, function returns **CRYPTO_SUBSYS_WRONG_SIGNATURE** status.

Function can return following status codes in case of various errors:

- CRYPTO_SUBSYS_NOT_INITIALIZED
- CRYPTO_SUBSYS_INVALID_HASH_ALGORITHM
- CRYPTO_SUBSYS_INVALID_PADDING_ALGORITHM
- CRYPTO_SUBSYS_INVALID_CIPHER_ALGORITHM
- CRYPTO_SUBSYS_INVALID_SIGNATURE_PARAMS
- CRYPTO_SUBSYS_INVALID_RSA_PUB_KEY
- CRYPTO_SUBSYS_INVALID_ECC_PUB_KEY
- CRYPTO_SUBSYS_INVALID_ECC_PUB_KEY_PARAMS
- CRYPTO_SUBSYS_UNKNOWN_ECC_CURVE
- CRYPTO_SUBSYS_SIGNATURE_VERIFICATION_ERROR

For digest_alg use one of the values declared in E_SIGNER_DIGESTS enumeration:

```
enum E_SIGNER_DIGESTS {
     ALG_NULL = 0,
     ALG_SHA,
     ALG_SHA_256,
     ALG_SHA_384,
     ALG_SHA_512,
     ALG_SHA_224,
     ALG_SHA_512_224,
     ALG_SHA_512_256,

     SIG_DIGEST_MAX_SUPPORTED
};
```

ALG_SHA is the designator for the SHA-1 algorithm.

For padding_alg use one of the values declared in E_SIGNER_RSA_PADDINGS enumeration:

```
enum E_SIGNER_RSA_PADDINGS {
     PAD_NULL = 0,
     PAD_PKCS1_V1_5,
     PAD_PKCS1_PSS,

     SIG_PAD_MAX_SUPPORTED
};
```

PAD_PKCS1 is an alias of the PAD_PKCS1_V1_5 padding algorithm:

```
#define PAD_PKCS1   PAD_PKCS1_V1_5
```

For cipher_alg use one of the values declared in E_SIGNER_CIPHERS enumeration:

```
enum E_SIGNER_CIPHERS {
     SIG_CIPHER_RSA = 0,
     SIG_CIPHER_ECDSA,

     SIG_CIPHER_MAX_SUPPORTED
};
```

When the signer cipher algorithm is SIG_CIPHER_ECDSA, padding_alg is ignored and you can freely use PAD_NULL i.e. value 0 as a padding_alg. ECDSA data alignment in use is described in RFC6979 (section 2.3. - Integer Conversions).

Function declaration (C language)

```
UFR_STATUS DigitalSignatureVerifyHash(uint32_t digest_alg,
                                      uint32_t padding_alg,
                                      uint32_t cypher_alg,
                                      const uint8_t *tbs,
                                      uint32_t tbs_len,
                                      const uint8_t *signature,
                                      uint32_t signature_len,
                                      const void *sig_params,
                                      uint32_t sig_params_len,
                                      const uint8_t *pub_key,
                                      uint32_t pub_key_len,
                                      const void *pub_key_params,
                                      uint32_t pub_key_params_len);
```

Parameters

`digest_alg`	in the E_SIGNER_DIGESTS enumeration.
`padding_alg`	in the E_SIGNER_RSA_PADDINGS enumeration. When the signer cipher algorithm is SIG_CIPHER_ECDSA, padding_alg is ignored and you can freely use PAD_NULL i.e. value 0 as a padding_alg. ECDSA data alignment in use is described in RFC6979 (section 2.3. - Integer Conversions).
`cypher_alg`	in the E_SIGNER_CIPHERS enumeration.
`tbs`	Pointer to the “To Be Signed“ data array i.e. hash or relatively short plain text message whose digital signature is being verified. "To Be Signed" is just a colloquial term for already signed data, which is the origin of the digital signature.
`tbs_len`	Length of the “To Be Signed“ array (in bytes).
`signature`	Pointer to the signature array.
`signature_len`	Length of the signature array (in bytes).
`sig_params`	Pointer to the additional signature parameters. Additional signature parameters are in use only when padding_alg is PAD_PKCS1_PSS and in that case this pointer should point to the unsigned 4-byte integer containing the value of the cryptographic salt length.
`sig_params_len`	Length of the additional signature parameters (in bytes). Additional signature parameters are in use only when padding_alg is PAD_PKCS1_PSS and in that case this value should be 4 i.e. size of unsigned 4-byte integer. In other cases this parameter is ignored.
`pub_key`	Pointer to the public key array. In the case of the RSA public key, this array should contain key modulus (‘N’).
`pub_key_len`	Length of the public key parameter `pub_key` (in bytes).
`pub_key_params`	Pointer to the additional public key parameters. In the case of the RSA public key, this array should contain a public key exponent array (‘e’). In the case of the ECC public key, this array should contain an elliptic curve definition array. To set an elliptic curve definition array you can use SetEllipticCurveByIndex() or SetEllipticCurveByName() functions.
`pub_key_params_len`	Length of the additional public key parameters (in bytes).

Machine Readable Travel Documents (MRTD) support

Fully supported from library version 5.0.12 and firmware version 5.0.22

Extended support (including MRTD validity verification) from library version 5.0.25 and firmware version 5.0.22

The uFCoder library from version 5.0.12 supports “Machine Readable Travel Documents“ (MRTD hereinafter), mainly ePassports. MRTD specification is maintained by the “International Civil Aviation Organization” (ICAO) and published in Doc 9303. eMRTD have embedded NFC tag which mandatory contains general information about the document holder, encoded facial image of the document holder and digital signatures of the containing data. Optionally embedded NFC tag may additionally contain fingerprints and eyes data with advanced security options. Advanced security options are not supported yet. In the embedded NFC tag data is stored in file logical structures. Files are named EF.DGx where EF stands for “elementary file” and DG stands for “data group”. For more details please read the ICAO MRTD specification (http://icao.int)

Authentication to the NFC tag embedded in an eMRTD and secure communication protocol can be established using different methods. For now, uFCoder library supports only Basic Access Control (BAC). Other possible secure communication protocols and authentication methods are Password Authenticated Connection Establishment (PACE) and optional Extended Access Control.

To read eMRTD data using Basic Access Control (BAC), first we have to get data from the so-called ‘Machine Readable Zone’ (MRZ). Data of interest are document number, document holder date of birth and document expiration date. Document number is always 9 characters long. Dates have to be in a “**YYMMDD**” format. In order to get MRZ Proto Key needed in subsequent steps, you can chose to enter MRZ data of interest using MRTD_MRZDataToMRZProtoKey() function or to enter MRZ subjacent row (only for TD3 MRZ format) using MRTD_MRZSubjacentToMRZProtoKey() function. Example of the TD3 MRZ format printed on the eMRTD document looks like this:

```
P<UTOERIKSSON<<ANNA<MARIA<<<<<<<<<<<<<<<<<<<

L898902C36UTO7408122F1204159ZE184226B<<<<<10
```

and, in this case, MRTD_MRZSubjacentToMRZProtoKey() function should receive pointer to null terminated string containing MRZ subjacent row i.e. “L898902C36UTO7408122F1204159ZE184226B<<<<<10” where “L898902C3” is document number, “740812” (12.08.1974) is date of birth and “120415” (15.04.2012) is expiration date.

MRTD_MRZDataToMRZProtoKey

Function description

In order to get the MRZ Proto Key needed in subsequent steps, you can call this function and pass it null terminated strings containing document number, document holder date of birth and document expiration date. After successful function execution MRZ Proto Key will be stored in a mrz_proto_key 25-byte array.

Function declaration (C language)

```
UFR_STATUS MRTD_MRZDataToMRZProtoKey(const char *doc_number,
                                     const char *date_of_birth,
                                     const char *date_of_expiry,
                                     uint8_t mrz_proto_key[25]);
```

Parameters

doc_number	Pointer to a null terminated string containing exactly 9 characters document number.
date_of_birth	Pointer to a null terminated string containing exactly 6 characters representing the date of birth in the “**YYMMDD**” format.
date_of_expiry	Pointer to a null terminated string containing exactly 6 characters representing expiration date in the “**YYMMDD**” format.
mrz_proto_key	This byte array will contain a calculated MRZ proto-key after successful function execution. This array must have allocated at least 25 bytes prior to calling this function.

MRTD_MRZSubjacentToMRZProtoKey

Function description

In order to get the MRZ Proto Key needed in subsequent steps, in the case of the TD3 MRZ format (88 totally character long), you can call this function and pass it a null terminated string containing the MRZ subjacent row. Example of the TD3 MRZ format printed on the eMRTD document looks like this:

```
P<UTOERIKSSON<<ANNA<MARIA<<<<<<<<<<<<<<<<<<<
L898902C36UTO7408122F1204159ZE184226B<<<<<10
```

This function should receive a pointer to a null terminated string containing MRZ subjacent row i.e. “L898902C36UTO7408122F1204159ZE184226B<<<<<10”.

Function declaration (C language)

```
UFR_STATUS MRTD_MRZSubjacentToMRZProtoKey(
                                        const char *mrz,
                                        uint8_t mrz_proto_key[25]);
```

Parameters

`mrz`	Pointer to a null terminated string containing MRZ data. According to ICAO Doc 9303-10, there it has three MRZ data formats: TD1,TD2 or TD3 formats. TD1 contains exactly 90 characters, TD2 contains exactly 72 characters and TD3 contains exactly 88 characters.
`mrz_proto_key`	This byte array will contain a calculated MRZ proto-key after successful function execution. This array must have allocated at least 25 bytes prior to calling this function.

MRTD_MRZSubjacentCheck

Function description

This function checks the subjacent row of a MRZ data integrity. Integrity check uses a special check digits calculation. The check digits permit readers to verify that data in the MRZ is correctly interpreted. If all of the check digits and composite check digit passed the verification process, this function returns UFR_OK status. Otherwise the function returns MRTD_MRZ_CHECK_ERROR status.

Function declaration (C language)

```
UFR_STATUS MRTD_MRZSubjacentCheck(const char *mrz);
```

Parameters

`mrz`	Pointer to a null terminated string containing MRZ data. According to ICAO Doc 9303-10, there it has three MRZ data formats: TD1,TD2 or TD3 formats. TD1 contains exactly 90 characters, TD2 contains exactly 72 characters and TD3 contains exactly 88 characters.

MRTDAppSelectAndAuthenticateBac

Function description

Use this function to authenticate to the eMRTD NFC tag using BAC. This function establishes a security channel for communication. Security channel is maintained using send_sequence_cnt parameter and channel session keys are ksenc (for encryption) and ksmac (for calculating MAC).

Function declaration (C language)

```
UFR_STATUS MRTDAppSelectAndAuthenticateBac(
                                      const uint8_t mrz_proto_key[25],
                                      uint8_t ksenc[16],
                                      uint8_t ksmac[16],
                                      uint64_t *send_sequence_cnt);
```

Parameters

`mrz_proto_key`	MRZ proto-key acquired using prior call to MRTD_MRZDataToMRZProtoKey() or MRTD_MRZSubjacentToMRZProtoKey() function.
`ksenc`	This array must have allocated at least 16 bytes prior to calling this function. This array will contain a session encryption key after successful function execution.
`ksmac`	This array must have allocated at least 16 bytes prior to calling this function. This array will contain a session key for calculating MAC after successful function execution.
`send_sequence_cnt`	After successful execution of this function, the pointer to this 64-bit value should be saved and forwarded at every subsequent call to MRTDFileReadBacToHeap() and/or other functions for reading eMRTD.

MRTDFileReadBacToHeap

Function description

Use this function to read files from the eMRTD NFC tag. You can call this function only after successfully established security channel by the previously called MRTDAppSelectAndAuthenticateBac() function. Session keys ksenc and ksmac, and also parameter send_sequence_cnt are acquired by the previously called MRTDAppSelectAndAuthenticateBac() function. After the successful call to this function, *output points to the file data read from an eMRTD file specified by the file_index parameter. Buffer, in which the data is stored, is automatically allocated on the memory heap during function execution. Maximum amount of data allocated can be 32KB. User is obligated to cleanup allocated data space, occupied by the **`*output`**, after use (e.g. by calling DLFree() or directly free() from the C/C++ code).

Function declaration (C language)

```
UFR_STATUS MRTDFileReadBacToHeap(const uint8_t *file_index,
                                 uint8_t **output,
                                 uint32_t *output_length,
                                 const uint8_t ksenc[16],
                                 const uint8_t ksmac[16],
                                 uint64_t *send_sequence_cnt);
```

Parameters

file_index	Parameter that specifies the file we want to read from the eMRTD. This is a pointer to byte array containing exactly two bytes designating eMRTD file. Those two bytes are file identificator (FID) and there is a list of FIDs:
	EF.COM = {0x01, 0x1E}
	EF.DG1 = {0x01, 0x01}
	EF.DG2 = {0x01, 0x02}
	EF.DG3 = {0x01, 0x03}
	EF.DG4 = {0x01, 0x04}
	EF.DG5 = {0x01, 0x05}
	EF.DG6 = {0x01, 0x06}
	EF.DG7 = {0x01, 0x07}
	EF.DG8 = {0x01, 0x08}
	EF.DG9 = {0x01, 0x09}
	EF.DG10 = {0x01, 0x0A}
	EF.DG11 = {0x01, 0x0B}
	EF.DG12 = {0x01, 0x0C}
	EF.DG13 = {0x01, 0x0D}
	EF.DG14 = {0x01, 0x0E}
	EF.DG15 = {0x01, 0x0F}
	EF.DG16 = {0x01, 0x10}
	EF.SOD = {0x01, 0x1D}

output	After the successful call to this function, this pointer will point to the pointer on the file data read from an eMRTD file specified by the **file_index** parameter. Buffer, in which the data is stored, is automatically allocated during function execution. Maximum amount of data allocated can be 32KB. There is a programmer responsibility to cleanup allocated data (e.g. by calling DLFree(cert) or directly free(cert) from the C/C++ code).
output_length	After the successful call to this function, this pointer is pointed to the size of the file data read from an eMRTD file specified by the **file_index** parameter.
ksenc	Session encryption key acquired using prior call to MRTDAppSelectAndAuthenticateBac() function.
ksmac	Session key for calculating MAC acquired using prior call to MRTDAppSelectAndAuthenticateBac() function.
send_sequence_cnt	This pointer should point to a 64-bit value initialized by the previously successful call to MRTDAppSelectAndAuthenticateBac() function. Pointer to this 64-bit value should be saved and forwarded at every subsequent call to this function and/or other functions used for reading eMRTD.

MRTDGetDGTagListFromCOM

Function description

Function declaration (C language)

```
UFR_STATUS MRTDGetDGTagListFromCOM(const uint8_t *com,
                                   uint32_t com_len,
                                   uint8_t **dg_list,
                                   uint8_t *dg_list_cnt);
```

Parameters

`com`	Pointer to the buffer containing EF.COM content.
`com_len`	Length of the EF.COM content.
`dg_list`	After the successful call to this function, this pointer will point to the pointer on the dg_list.
`dg_list_cnt`	After successful function execution, this pointer will point to the variable containing the size of the dg_list in bytes i.e. data groups count.

MRTDValidate

Function description

This function validates data groups read from the eMRTDocument. All the elements needed for a validation are recorded into the eMRTD and additional CSCA certificate (Country Signing Certificate Authority). During function execution, hash values of the data groups are validated. Data groups hash values have to be the same as those values embedded in the SOD file which is signed by the private key corresponding to the DS certificate. The DS certificate has to be included in the SOD file too. SOD content is a special case of the PKCS#7 ASN.1 DER encoded structure. Finally, DS certificate signature is validated by the external CSCA certificate which is proof of the valid certificates chain of thrust.

The countries provided their CSCA certificates on the specialized Internet sites. CSCA certificates can be in PEM (base64 encoded) or binary files (there having extensions such as PEM, DER, CER, CRT…). Some countries have Master List files that include certificates from other countries with which they have bilateral agreements. Those Master List files have an ".ml" file extension. Additionally, the ICAO Public Key Directory (PKD) is a central repository for exchanging the information required to authenticate ePassports. For more details you can visit the ICAO PKD web site.

Function declaration (C language)

```
UFR_STATUS MRTDValidate(const char *cert_storage_folder,
                        char **out_str,
                        const char *newln,
                        uint32_t verbose_level,
                        uint8_t ksenc[16],
                        uint8_t ksmac[16],
                        uint64_t *send_sequence_cnt);
```

Parameters

`cert_storage_folder`	Pointer to the zero terminated string which should contains path to the folder containing CSCA certificates and/or ICAO Master List files.
`out_str`	After successful function execution, this pointer will point to the pointer on the zero terminated string containing verbose printout of the validation steps. Various printout details are determined by the value of the **verbose_level** function parameter.
`newln`	Pointer to the zero terminated string which contains the new line escape sequence for the target system. In the general case it should be “\n” but on some systems can be “\r” or “\r\n”.

`verbose_level`	One of the values defined in the **E_PRINT_VERBOSE_LEVELS** enumeration:
	`enum E_PRINT_VERBOSE_LEVELS {`
	`    PRINT_NONE,`
	`    PRINT_ESSENTIALS,`
	`    PRINT_DETAILS,`
	`    PRINT_ALL_PLUS_STATUSES,`
	`};`

`ksenc`	Session encryption key acquired using prior call to MRTDAppSelectAndAuthenticateBac() function.
`ksmac`	Session key for calculating MAC acquired using prior call to MRTDAppSelectAndAuthenticateBac() function.
`send_sequence_cnt`	This pointer should point to a 64-bit value initialized by the previously successful call to MRTDAppSelectAndAuthenticateBac() function. Pointer to this 64-bit value should be saved and forwarded at every subsequent call to this function and/or other functions used for reading eMRTD.

MRTDParseDG1ToHeap

Function description

Use this function to get verbose “printout” string containing MRZ (Machine Readable Zone) parsed data from the content of the EF.DG1 MRTD file. Function supports TD1, TD2 and TD3 Data Group 1 formats as defined in the ICAO Doc 9303-10 (seventh edition, 2015).

Function automatically allocates memory on the heap, which *sbuffer parameter will point to after successful execution. User is obligated to cleanup allocated memory space, occupied by the *sbuffer, after use (e.g. by calling DLFree(sbuffer) or directly free(sbuffer) from the C/C++ code).

Function declaration (C language)

```
UFR_STATUS MRTDParseDG1ToHeap(const uint8_t *dg1,
                              uint8_t dg1_len,
                              const char *newln,
                              char **sbuffer);
```

Parameters

dg1	Pointer to the buffer containing EF.DG1 content.
dg1_len	Length of the EF.DG1 content.
newln	Pointer to the zero terminated string which contains the new line escape sequence for the target system. In the general case it should be “\n” but on some systems can be “\r” or “\r\n”.
sbuffer	After successful function execution, this pointer will point to the pointer on the zero terminated string containing verbose printout of the parsed EF.DG1 data.

MRTDGetImageFromDG2

Function description

Use this function to extract the facial image from the EF.DG2 content. This function receives EF.DG2 content through ***dg2** parameter, parse it and searches for facial image data. Pointer ***image** points to facial image data within ***dg2** memory buffer, after successful function execution.

Function declaration (C language)

```
UFR_STATUS MRTDGetImageFromDG2(const uint8_t *dg2,
                               uint32_t dg2_size,
                               uint8_t **image,
                               uint32_t *image_size,
                               uint32_t *img_type);
```

Parameters

`dg2`	Pointer to the buffer containing EF.DG2 content.
`dg2_size`	Length of the EF.DG2 content.
`image`	After successful function execution, this pointer will point to the pointer on the image data which is physically located in the `dg2` buffer.
`image_size`	After successful function execution, the variable on which this pointer points to, will contain image data length.

`img_type`	After successful function execution, the variable on which this pointer points to, will contain image type. Image type can be one of the values defined in the E_MRTD_IMG_TYPE enumeration:
	enum E_MRTD_IMG_TYPE {
	MRTD_IMG_JPEG = 0,
	MRTD_IMG_JP2 = 1,
	MRTD_IMG_JPEG2000 = 1, // Alias for the MRTD_IMG_JP2
	MRTD_IMG_TYPE_UNKNOWN = 0xFFFFFFFF
	};

MRTDGetImageFromDG2ToFile

Function description

Use this function to extract facial image from the EF.DG2 content and save it to file on the file system. This function receives EF.DG2 content through ***dg2** parameter, parse it and searches for facial image data. After successful function execution, file with path and name specified with an **file_name_without_extension** parameter is saved. File extension is determined automatically according to the image type.

Function declaration (C language)

```
UFR_STATUS MRTDGetImageFromDG2ToFile(
                              const uint8_t *dg2,
                              uint32_t dg2_size,
                              const char *file_name_without_extension);
```

Parameters

`dg2`	Pointer to the buffer containing EF.DG2 content.
`dg2_size`	Length of the EF.DG2 content.
`file_name_without_extension`	Pointer to the zero terminated string containing file path and name without an extension which is automatically determined according to the image type.

MRTDGetDgIndex

Function description

Use this function to get an index of the data groups from EF.DG1 to DG16 i.e. 1 to 16. For EF.COM, EF.SOD and invalid tag function returns 0.

Function declaration (C language)

```
uint32_t MRTDGetDgIndex(uint8_t dg_tag);
```

Parameters

`dg_tag`	Data Group tag: ● tag of the EF.COM is 0x60 ● tag of the EF.DG1 is 0x61 ● tag of the EF.DG2 is 0x75 ● tag of the EF.DG3 is 0x63 ● tag of the EF.DG4 is 0x76 ● tag of the EF.DG5 is 0x65 ● tag of the EF.DG6 is 0x66 ● tag of the EF.DG7 is 0x67 ● tag of the EF.DG8 is 0x68 ● tag of the EF.DG9 is 0x69 ● tag of the EF.DG10 is 0x6a ● tag of the EF.DG11 is 0x6b ● tag of the EF.DG12 is 0x6c ● tag of the EF.DG13 is 0x6d ● tag of the EF.DG14 is 0x6e ● tag of the EF.DG15 is 0x6f ● tag of the EF.DG16 is 0x70 ● tag of the EF.SOD is 0x77

MRTDGetDgName

Function description
Use this function to get a name of the data group. Function returns pointer to the zero terminated string ("EF.COM", “EF.DG1”, “EF.DG2”, … , “EF.SOD”). For invalid tag function returns zero terminated string “NOT DEFINED”.

Function declaration (C language)

```
c_string MRTDGetDgName(uint8_t dg_tag);
```

Parameters

`dg_tag`	Data Group tag: ● tag of the EF.COM is 0x60 ● tag of the EF.DG1 is 0x61 ● tag of the EF.DG2 is 0x75 ● tag of the EF.DG3 is 0x63 ● tag of the EF.DG4 is 0x76 ● tag of the EF.DG5 is 0x65 ● tag of the EF.DG6 is 0x66 ● tag of the EF.DG7 is 0x67 ● tag of the EF.DG8 is 0x68 ● tag of the EF.DG9 is 0x69 ● tag of the EF.DG10 is 0x6a ● tag of the EF.DG11 is 0x6b ● tag of the EF.DG12 is 0x6c ● tag of the EF.DG13 is 0x6d ● tag of the EF.DG14 is 0x6e ● tag of the EF.DG15 is 0x6f ● tag of the EF.DG16 is 0x70 ● tag of the EF.SOD is 0x77

TLS 1.2 with TLS/SSL Client Certificate Authentication using Generic Identity Device Specification (GIDS) smart card support

Support added in library version 5.0.57

Nowadays many HTTPS servers support user authentication utilizing TLS/SSL user certificate and digital cryptographic signing. Most of the TLS/SSL HTTPS clients only support software digital signing methods, using a private key associated with the TLS/SSL user certificate. In this case, the private key with the certificate is usually stored in the .p12 or .pfx file according to PKCS#12 specification. Storing .pfx files and their passwords poses a significant security risk. For this reason, the use of smart cards for the purpose of storing digital certificates and private keys with applets that perform digital signing is becoming more common. One of the most commonly used specifications for this purpose is Generic Identity Device Specification (GIDS). GIDS is the only card (with PIV) to be deployed on all Windows versions starting with Windows 7. GIDS is a plug &

play card applet.

For reasons described we have implemented a TLS 1.2 HTTPS client in our uFCoder supporting TLS/SSL user certificate authentication using GIDS smart card for digital signing. Client is implemented using low level sockets APIs which are supported in all of the relevant operating systems already supported by the uFCoder software library.

DL_TLS_SetClientCertificate
Added in library version 5.0.57

Function description

Function declaration (C language)

```
UFR_STATUS DL_TLS_SetClientCertificate(uint32_t cert_type,
                                       const char *cert,
                                       uint32_t cert_len);
```

Parameters

`cert_type:` for this parameter you can use one of two enumerated values defined in uFCoder.h include file: **X509_PEM** = 0 or **X509_GIDS_NFC** = 3.

If you use **X509_PEM**, you have to invoke this function with a valid X.509 client (i.e. leaf or end-entity) certificate to which the `cert` parameter points and `cert_len` defines its size.

Although we do not recommend the use of software digital signing during TLS/SSL client certificate authentication, the uFCoder library still allows its use.

Allso, if you use **X509_PEM**, you have to invoke `DL_TLS_SetClientX509PrivateKey_PEM()` function after calling this one.

DL_TLS_SetClientX509PrivateKey_PEM
Added in library version 5.0.57

Function description

Although we do not recommend the use of software digital signing during TLS/SSL client certificate authentication, the uFCoder library still allows its use.

If you use **X509_PEM** as a parameter of the `DL_TLS_SetClientCertificate()` function call, you have to invoke this function thereafter.

Function declaration (C language)

```
UFR_STATUS DL_TLS_SetClientX509PrivateKey_PEM(const char *priv_key,
                                              uint32_t key_bytes_len);
```

Parameters

`priv_key`: pointer to the private key in PEM format, base64 encoded beginning with "-----BEGIN RSA PRIVATE KEY-----" string and ending with "-----END RSA PRIVATE KEY-----" string. Base64 encoded values should be separated with CR and/or LF ASCII characters on every 64 characters, as stated in the X.509 specification.

`key_bytes_len`: PEM key size in bytes

DL_TLS_SetGIDS_AID
(to be implemented in one of the future library version)

Function description

If the official Generic Identity Device Specification (GIDS) smart card applet is in use then you shouldn't call this function at all. uFCoder library uses official GIDS AID for applet selection by default. In case you use a different smart card applet, compatible with GIDS but with different Applet ID, you can set appropriate AID using this function.

Function declaration (C language)

```
UFR_STATUS DL_TLS_SetGIDS_AID(uint32_t encoding,
                              const char *AID,
                              uint32_t AID_len);
```

Parameters

`encoding`	This parameter can have one of the two encoding types defined in the **E_BIT_ENCODINGS** enumeration defined in the uFCoder.h header file. Those encoding types applied to this function can be: **ENCODING_BIN = 0** or **ENCODING_HEX = 1**.
`AID`	This char pointer should point to a string containing GIDS applet AID. If parameter **encoding** is equal to **ENCODING_HEX**, encoding of GIDS applet AID should be in ASCII pairs of hexadecimal digits. Otherwise, this char pointer should have NULL value. If parameter **encoding** is equal to **ENCODING_BIN**, encoding of GIDS applet AID should be a binary byte array. If this pointer has a NULL value then default GIDS applet AID will be restored.
`AID_len`	This parameter is GIDS applet AID length in bytes, so if parameter

	encoding is equal to **ENCODING_BIN** AID_len is equal to the length of the binary byte array AID points to. If the parameter **encoding** is equal to **ENCODING_HEX** then **`AID_len`** should be half the size of the hexadecimal ASCII pairs. If this pointer is 0 then default GIDS applet AID will be restored.

DL_TLS_Request
added in library version 5.0.57

Function description

This function transceive HTTPS GET request over TLS 1.2 secure connection implementing TLS/SSL user certificate authentication on server request. Request doesn't contain HTTP body and use minimal of the HTTP headers:

GET *resource_path* **HTTP/1.1**
Host: *url*:*port*
Accept: */*
Connection: **close**

Function declaration (C language)

```
UFR_STATUS DL_TLS_Request(char **read_buffer,
                          uint32_t *received_len,
                          const char *url,
                          const char *resource_path,
                          uint16_t port,
                          char *PIN,
                          uint8_t PIN_len);
```

Parameters

`read_buffer`	Pointer to char pointer which will, after successful function execution, points to a HTTP response, including HTTP response headers and content. In case of request failure *read_buffer will have NULL value. User is obligated to cleanup allocated memory space, occupied by the *read_buffer, after use (e.g. by calling DLFree(sbuffer) or directly free(sbuffer) from the C/C++ code).
`received_len`	Length of the HTTP response after successful function execution. In case of request failure *received_len will be 0.
`url`	Char pointer to the zero terminated string, contains request URL. e.g. "certificates.d-logic.com".

resource_path	Char pointer to the zero terminated string, contains a request path to the resource e.g. “/” or “/favicon.ico”.
port	TCP port, 443 in general for HTTPS protocol
PIN	In case of GIDS smart card in use, this char pointer should point to a string containing GIDS applet ASCII encoded PIN code. Otherwise, this char pointer should have NULL value.
PIN_len	In case of GIDS smart card applet is in use, this parameter should contain PIN code size. Otherwise, this parameter should be 0.

EMV FUNCTIONS

Support added in library version 5.0.41
EMV standard is managed and maintained by a group of financial companies known as EMVCo. EMV stands for Europay, Mastercard, and Visa. It is a standard in the credit card industry for integrated circuit cards, point-of-sale (POS) terminals, and automated teller machines (ATMs). EMV standard covers the physical aspects of cards and terminals, as well as technical capabilities and data management. It applies to cards that require swiping (called contact cards) and to cards that do not (contactless cards), as well as to new standards being developed for ecommerce and online transactions. From library version 5.0.41 functions for interacting with contactless cards conforming to EMV standard using our uFR series readers have been introduced.

Interaction with EMV capable cards and our uFR series readers is supported by utilizing NFC communication for transmitting APDU commands to contactless cards that conform to the EMV standard. Communication protocol for transmitting and receiving data from EMV chips is defined by the EMV Chip Specifications, this protocol defines a series of steps that are implemented internally in our library. During an EMV transaction, the chip is capable of processing information and defines many of the rules that determine the outcome of the transaction. The terminal helps enforce the rules set by the issuer on the chip. These rules can include enforcing services such as offline data authentication, verifying the cardholder identity via PIN or signature, online authorisation and so on.

Currently, aforementioned authentication methods are **not** supported for functions that are implemented and are **not** necessary for their execution.

Due to the necessary APDU command transmission for a proper execution of these functions, usage of **SetISO14443_4_Mode()** function at the beginning of interaction with EMV capable card is necessary.**s_block_deselect()** function should be called when done interacting to resume RF polling of uFR series reader. This order of function execution is mandatory.

EMV_GetPAN

Function description
Used for extracting the credit card PAN number. Must provide card's Payment System Environment (PSE1 or PSE2).

Function declaration (C language)

```
UFR_STATUS EMV_GetPAN(c_string df_name, char* pan_str);
```

Parameters

df_name	Name of Payment System Environment used. Use value **"1PAY.SYS.DDF01"** for **PSE1**, or **"2PAY.SYS.DDF01"** for **PSE2**
pan_str	Pointer to char array containing credit card PAN.

EMV_GetLastTransaction

Function description
Used for extracting details about the last transaction stored in a credit card. Must provide card's Payment System Environment (PSE1 or PSE2).

Function declaration (C language)

```
UFR_STATUS EMV_GetLastTransaction(c_string df_name, char*
last_transaction_info);
```

Parameters

df_name	Name of Payment System Environment used. Use value **"1PAY.SYS.DDF01"** for **PSE1**, or **"2PAY.SYS.DDF01"** for **PSE2**
last_transaction_info	Pointer to char array containing details about the last transaction stored in the card.

BASE HD UFR SUPPORT FUNCTIONS

UfrXrcLockOn

Function description
Electric strike switches when the function called. Pulse duration determined by function.

Function declaration (C language)

```
UFR_STATUS UfrXrcLockOn(uint8_t pulse_duration);
```

Parameter

pulse_duration	pulse_duration is strike switch on period in ms

UfrXrcRelayState

Function description

Function switches relay.

Function declaration (C language)

```
UFR_STATUS UfrXrcRelayState(uint8_t state);
```

Parameter

`state`	if the state is 1, then relay is switch on, and if state is 0, then relay is switch off

UfrXrcGetIoState

Function description

Function returns states of 3 IO pins.

Function declaration (C language)

```
UFR_STATUS UfrXrcGetIoState(uint8_t *intercom,
                            uint8_t *door,
                            uint8_t *relay_state);
```

Parameters

`intercom`	shows that there is voltage at the terminals for intercom connection, or not
`door`	shows that the door's magnetic switch opened or closed
`relay_state`	is 1 if relay switch on, and 0 if relay switch off

FUNCTIONS FOR RF ANALOG REGISTERS SETTING

These functions allow you to adjust the value of several registers on PN512. These are registers: RFCfgReg, RxThresholdReg, GsNOnReg, GsNOffReg, CWGsPReg, ModGsPReg. This can be useful if you want to increase the operation distance of card, or when it is necessary to reduce the impact of environmental disturbances.

SetRfAnalogRegistersTypeA

SetRfAnalogRegistersTypeB

SetRfAnalogRegistersISO14443_212

SetRfAnalogRegistersISO14443_424

Function description
Functions allow adjusting values of registers RFCfgReg and RxThresholdReg. Registry setting is applied to the appropriate type of communication with tag. There are ISO14443 Type A, ISO14443 TypeB, and ISO14443-4 on higher communication speeds (211 and 424 Kbps).

Functions declaration (C language):

```
UFR_STATUS SetRfAnalogRegistersTypeA(uint8_t ThresholdMinLevel,
                                     uint8_t ThresholdCollLevel,
                                     uint8_t RFLevelAmp,
                                     uint8_t RxGain,
                                     uint8_t RFLevel);

UFR_STATUS SetRfAnalogRegistersTypeB(uint8_t ThresholdMinLevel,
                                     uint8_t ThresholdCollLevel,
                                     uint8_t RFLevelAmp,
                                     uint8_t RxGain,
                                     uint8_t RFLevel);

UFR_STATUS SetRfAnalogRegistersISO14443_212(
                                     uint8_t ThresholdMinLevel,
                                     uint8_t ThresholdCollLevel,
                                     uint8_t RFLevelAmp,
                                     uint8_t RxGain,
                                     uint8_t RFLevel);

UFR_STATUS SetRfAnalogRegistersISO14443_424(
                                     uint8_t ThresholdMinLevel,
                                     uint8_t ThresholdCollLevel,
                                     uint8_t RFLevelAmp,
                                     uint8_t RxGain,
                                     uint8_t RFLevel);
```

Parameters

ThresholdMinLevel	value in range 0 - 15, part of RxThresholdReg
ThresholdCollLevel	value in range 0 - 7, part of RxThresholdReg
RFLevelAmp	0 or 1, part of RFCfgReg
RxGain	value in range 0 - 7, part of RFCfgReg
RFLevel	value in range 0 - 15, part of RFCfgReg

SetRfAnalogRegistersTypeADefault

SetRfAnalogRegistersTypeBDefault

SetRfAnalogRegistersISO14443_212Default

SetRfAnalogRegistersISO14443_424Default

Function description

The functions set the factory default settings of the registers RFCfgReg and RxThresholdReg.

Functions declaration (C language):

```
UFR_STATUS SetRfAnalogRegistersTypeADefault(void);

UFR_STATUS SetRfAnalogRegistersTypeBDefault(void);

UFR_STATUS SetRfAnalogRegistersISO14443_212Default(void);

UFR_STATUS SetRfAnalogRegistersISO14443_424Default(void);
```

GetRfAnalogRegistersTypeA

GetRfAnalogRegistersTypeB

GetRfAnalogRegistersISO14443_212

GetRfAnalogRegistersISO14443_424

Function description

The functions read the value of the registers RFCfgReg and RxThresholdReg.

Functions declaration (C language):

```
UFR_STATUS GetRfAnalogRegistersTypeA(uint8_t *ThresholdMinLevel,
uint8_t *ThresholdCollLevel,
                                     uint8_t *RFLevelAmp,
                                     uint8_t *RxGain,
                                     uint8_t *RFLevel);

UFR_STATUS GetRfAnalogRegistersTypeB(uint8_t *ThresholdMinLevel,
                                     uint8_t *ThresholdCollLevel,
                                     uint8_t *RFLevelAmp,
                                     uint8_t *RxGain,
                                     uint8_t *RFLevel);

UFR_STATUS GetRfAnalogRegistersISO14443_212(
                                     uint8_t *ThresholdMinLevel,
                                     uint8_t *ThresholdCollLevel,
                                     uint8_t *RFLevelAmp,
                                     uint8_t *RxGain,
                                     uint8_t *RFLevel);

UFR_STATUS GetRfAnalogRegistersISO14443_424(
                                     uint8_t *ThresholdMinLevel,
                                     uint8_t *ThresholdCollLevel,
                                     uint8_t *RFLevelAmp,
                                     uint8_t *RxGain,
                                     uint8_t *RFLevel);
```

Parameters

ThresholdMinLevel	value in range 0 - 15, part of RxThresholdReg
ThresholdCollLevel	value in range 0 - 7, part of RxThresholdReg
RFLevelAmp	0 or 1, part of RFCfgReg
RxGain	value in range 0 - 7, part of RFCfgReg
RFLevel	value in range 0 - 15, part of RFCfgReg

SetRfAnalogRegistersTypeATrans

SetRfAnalogRegistersTypeBTrans

Function description

Functions allow adjusting values of registers RFCfgReg, RxThresholdReg, GsNOnReg, GsNOffReg, CWGsPReg, ModGsPReg. Registry setting is applied to the appropriate type of communication with tag. There are ISO14443 Type A, ISO14443 TypeB, and ISO14443-4 on higher communication speeds (211 and 424 Kbps).

Functions declaration (C language):

```
UFR_STATUS SetRfAnalogRegistersTypeATrans(
                               uint8_t ThresholdMinLevel,
                               uint8_t ThresholdCollLevel,
                               uint8_t RFLevelAmp,
                               uint8_t RxGain,
                               uint8_t RFLevel,
                               uint8_t CWGsNOn,
                               uint8_t ModGsNOn,
                               uint8_t CWGsP,
                               uint8_t CWGsNOff,
                               uint8_t ModGsNOff);
```

```
UFR_STATUS SetRfAnalogRegistersTypeBTrans(
                               uint8_t ThresholdMinLevel,
                               uint8_t ThresholdCollLevel,
                               uint8_t RFLevelAmp,
                               uint8_t RxGain,
                               uint8_t RFLevel,
                               uint8_t CWGsNOn,
                               uint8_t ModGsNOn,
                               uint8_t CWGsP,
                               uint8_t ModGsP);
```

Parameters

`ThresholdMinLevel`	value in range 0 - 15, part of RxThresholdReg
`ThresholdCollLevel`	value in range 0 - 7, part of RxThresholdReg
`RFLevelAmp`	0 or 1, part of RFCfgReg
`RxGain`	value in range 0 - 7, part of RFCfgReg
`RFLevel`	value in range 0 - 15, part of RFCfgReg
`CWGsNOn`	value in range 0 - 15, part of GsNOnReg
`ModGsNOn`	value in range 0 - 15, part of GsNOnReg
`CWGsP`	value of CWGsPReg (0 - 47)
`CWGsNOff`	value in range 0 - 15, part of GsNOffReg
`ModGsNOff`	value in range 0 - 15, part of GsNOffReg
`ModGsP`	value of ModGsPReg (0 - 47)

GetRfAnalogRegistersTypeATrans

GetRfAnalogRegistersTypeBTrans

Function description
The functions read the value of the registers RFCfgReg, RxThresholdReg, GsNOnReg, GsNOffReg, CWGsPReg, ModGsPReg.

Functions declaration (C language):

```
UFR_STATUS GetRfAnalogRegistersTypeATrans(
                              uint8_t *ThresholdMinLevel,
                              uint8_t *ThresholdCollLevel,
                              uint8_t *RFLevelAmp,
                              uint8_t *RxGain,
                              uint8_t *RFLevel,
                              uint8_t *CWGsNOn,
                              uint8_t *ModGsNOn,
                              uint8_t *CWGsP,
                              uint8_t *CWGsNOff,
                              uint8_t *ModGsNOff);
```

```
UFR_STATUS GetRfAnalogRegistersTypeBTrans(
                              uint8_t *ThresholdMinLevel,
                              uint8_t *ThresholdCollLevel,
                              uint8_t *RFLevelAmp,
                              uint8_t *RxGain,
                              uint8_t *RFLevel,
                              uint8_t *CWGsNOn,
                              uint8_t *ModGsNOn,
                              uint8_t *CWGsP,
                              uint8_t *ModGsP);
```

Parameters

ThresholdMinLevel	value in range 0 - 15, part of RxThresholdReg
ThresholdCollLevel	value in range 0 - 7, part of RxThresholdReg
RFLevelAmp	0 or 1, part of RFCfgReg
RxGain	value in range 0 - 7, part of RFCfgReg
RFLevel	value in range 0 - 15, part of RFCfgReg
CWGsNOn	value in range 0 - 15, part of GsNOnReg
ModGsNOn	value in range 0 - 15, part of GsNOnReg
CWGsP	value of CWGsPReg (0 - 47)
CWGsNOff	value in range 0 - 15, part of GsNOffReg
ModGsNOff	value in range 0 - 15, part of GsNOffReg
ModGsP	value of ModGsPReg (0 - 47)

FUNCTIONS FOR DEVICE SIGNALIZATION SETTINGS

GreenLedBlinkingTurnOn

Function description

The function allows the blinking of the green diode independently of the user's signaling command (default setting). This setting writes into the reader's EEPROM, and it loads when the reader starts up.

Function declaration (C language)

```
UFR_STATUS GreenLedBlinkingTurnOn(void);
```

GreenLedBlinkingTurnOff

Function description

The function prohibits the blinking of the green diode independently of the user's signaling command. LED and sound signaling occurs only on the user command. This setting writes into the reader's EEPROM, and it loads when the reader starts up.

Function declaration (C language)

```
UFR_STATUS GreenLedBlinkingTurnOff(void);
```

UfrRgbLightControl

Function description

For classic uFR PLUS devices only.

The function prohibits the blinking of the green diode (if this option is set), and sets color on RGB diodes. This color stays on diodes until this function sets the parameter "enable" to 0.

Function declaration (C language)

```
UFR_STATUS UfrRgbLightControl(uint8_t red,
                              uint8_t green,
                              uint8_t blue,
                              uint8_t intensity,
                              uint8_t enable);
```

Parameters

red	value of red color (0 - 255)
green	value of green color (0 - 255)
blue	value of blue color (0 - 255)
intensity	value of color intensity in percent (0 - 100)
enable	1 - enable 0 - disable

UfrRgbLightControlSleep

Function description

From version 5.0.64.

The function sets color on the RGB diodes. This setting will appear when the reader is in sleep mode. Function adjusts the period, and duration of impulse of light. The period is a product of approximately two seconds (2s, 4s, 6s, 8s,...). Maximal duration of impulse of light is 2000 ms.

Function declaration (C language)

```
UFR_STATUS UfrRgbLightControlSleep(uint8_t red,
                                   uint8_t green,
                                   uint8_t blue,
                                   uint8_t intensity,
                                   uint8_t period,
                                   uint16_t duration,
                                   uint8_t enable);
```

Parameters

red	value of red color (0 - 255)
green	value of green color (0 - 255)
blue	value of blue color (0 - 255)
intensity	value of color intensity in percent (0 - 100)
period	number of the 2 seconds period. (1 = 2s, 2 = 4s, 3 = 6s, …)
duration	duration of impulse of light in ms.
enable	1 - enable 0 - disable

UfrRgbLightControlRfPeriod

Function description

From version 5.0.66.

The function sets color on the RGB diodes, period of inactivity NFC RF and RGB, and duration of activity NFC RF and RGB. In the inactivity period NFC RF is off, and RGB light is off. In the activity period NFC RF is on, and RGB may be on. Function also sets the number of omitted activity periods, when the RGB light is off. For example if the inactivity period is 400ms, activity duration is 50ms, and number of omitted activity periods is 5, RGB lights will be on 50ms at every 2250ms.

Function declaration (C language)

```
UFR_STATUS UfrRgbLightControlRfPeriod(uint8_t red,
                                   uint8_t green,
                                   uint8_t blue,
                                   uint8_t intensity,
                                   uint16_t period,
                                   uint16_t duration,
                                   uint8_t rgb_omitted_cnt,
                                   uint8_t enable);
```

Parameters

red	value of red color (0 - 255)

green	value of green color (0 - 255)
blue	value of blue color (0 - 255)
intensity	value of color intensity in percent (0 - 100)
period	inactivity period in ms
duration	duration of activity period in ms
rgb_omitted_cnt	number of omitted activity periods
enable	1 - enable 0 - disable

RgbControl

Function description
From version 5.0.55.

Before the function calls, the function GreenLedBlinkingTurnOff must be called, or the reader is already in mode of blocking automatic signalization. Function sets the color of the RGB diodes. This color stays on the RGB until the function GreenLedBlinkingTurnOn is called. Intensity of light is defined by a parameter stored using the function SetRgbIntensity.

Function declaration (C language)

```
UFR_STATUS RgbControl(uint8_t red, uint8_t green, uint8_t blue);
```

Parameters

red	value of red color (0 - 255)
green	value of green color (0 - 255)
blue	value of blue color (0 - 255)

FUNCTIONS FOR DISPLAY CONTROL

SetDisplayData

Function description
This feature works with the LED RING 24 display module. Function enables sending data to the display. A string of data contains information about the intensity of color in each cell of the display. Each cell has three LEDs (red, green and blue). For each cell of the three bytes is necessary. The first byte indicates the intensity of the green color, the second byte indicates the intensity of the red color, and the third byte indicates the intensity of

blue color. For example, if the display has 16 cells, an array contains 48 bytes. Value of intensity is in the range from 0 to 255.

Function declaration (C language)

```
UFR_STATUS SetDisplayData(uint8_t *display_data,
                          uint8_t data_length);
```

Parameters

`display_data`	pointer to data array
`data_length`	number of data into array

SetRgbData

Function description

From version 5.0.55

Function has the same functionality as the function SetDisplayData. New feature is the RGB port selection. Internal port uses RGB diodes on the reader PCB. Card size reader has two diodes. XL reader has four diodes. External port uses LED RING with RGB diodes. Before the function calls, the function GreenLedBlinkingTurnOff must be called, or the reader is already in mode of blocking automatic signalization. Function sets the color of the RGB diodes. This color stays on the RGB until the function GreenLedBlinkingTurnOn is called. Intensity of light is defined by a parameter stored using the function SetRgbIntensity.

Function declaration (C language)

```
UFR_STATUS SetRgbData(uint8_t *display_data,
                      uint8_t data_length,
                      uint8_t port_name);
```

Parameters

`display_data`	pointer to data array
`data_length`	number of data into array
`port_name`	EXTERNAL_RGB_PORT INTERNAL_RGB_PORT

SetDisplayIntensity
SetRgbIntensity (alias from version 5.0.55)

Function description

Function sets the intensity of light on the display. Value of intensity is in the range 0 to 100. This value writes into the reader's EEPROM, and it loads when the reader starts up.

Function declaration (C language)

```
UFR_STATUS SetDisplayIntensity(uint8_t intensity);
```

Parameter

`intensity`	value of intensity (0 – 100)

GetDisplayIntensity
GetRgbIntensity (alias from version 5.0.55)

Function description

Function gets the intensity of light on the display.

Function declaration (C language)

```
UFR_STATUS GetDisplayIntensity(uint8_t *intensity);
```

Parameter

`intensity`	pointer to intensity

Functions for transceive mode

For uFR PLUS devices only

In this mode, the data is entered via the serial port transmitted through the RF field to the card, and the card response is transmitted to the serial port.

card_transceive_mode_start

Function description

Function sets the parameters for transceive mode. If the hardware CRC option is used, then only command bytes sent to card (hardware will add two bytes of CRC to the end of RF packet). If this option did not use, then command bytes and two bytes of CRC sent to card (i.e. ISO14443 typeA CRC). Timeout for card response in us sets.

Card is selected and waiting for commands.

Function declaration (C language)

```
UFR_STATUS card_transceive_mode_start(uint8_t tx_crc,
                                      uint8_t rx_crc,
                                      uint32_t rf_timeout,
                                      uint32_t uart_timeout);
```

Parameters

`tx_crc`	hardware RF TX crc using (1 - yes, 0 - no)
`rx_crc`	hardware RF RX crc using (1 - yes, 0 - no)
`rf_timeout`	timeout for card response in us
`uart_timeout`	timeout for UART response in ms

card_transceive_mode_stop

Function description

The function returns the reader to normal mode.

Function declaration (C language)

```
UFR_STATUS DL_API card_transceive_mode_stop(void);
```

uart_transceive

Function description

The function sends data through the serial port to the card.

Function declaration (C language)

```
UFR_STATUS DL_API uart_transceive(uint8_t *send_data,
                                  uint8_t send_len,
                                  uint8_t *rcv_data,
                                  uint32_t bytes_to_receive,
                                  uint32_t *rcv_len);
```

Parameters

`send_data`	pointer to data array for sending to card
`send_len`	number of bytes for sending
`rcv_data`	pointer to data array received from card
`bytes_to_receive`	expected number of bytes received from card
`rcv_len`	number of bytes received from card

Functions for Mifare Ultralight C card

For uFR PLUS devices only

ULC_ExternalAuth_PK

Function description

The 3DES authentication is executed using the transceive mode of reader. Pointer to array which contains 2K 3DES key (16 bytes) is parameter of this functions. Function don’t use the key which stored into reader. DES algorithm for authentication executes in host device, not in reader.

After authentication, the reader leaves the transceive mode, but stay in mode where the HALT command doesn’t sending to the card. In this mode user can use functions for block and linear reading or writing. Reader stay into this mode, until the error during reading data from card, or writing data into card occurs, or until the user calls function **card_halt_enable()**.

Function declaration (C language)

```
UFR_STATUS DL_API ULC_ExternalAuth_PK(uint8_t *key);
```

Parameter

`key`	pointer to data array of 16 bytes which contains 2K 3DES key

card_halt_enable

Function description

Function enables normal working mode of reader, after leaving the transceive working mode with blocking card HALT command in the main loop.

Function declaration (C language)

```
UFR_STATUS DL_API card_halt_enable(void);
```

ULC_write_3des_key_no_auth
ULC_write_3des_key_factory_key
ULC_write_3des_key

Function description

3DES key is stored into card in pages 44 - 47. Byte order is described in the card datasheet. The user can write key into card by function BlockWrite for each page (44 - 47) after successful 3DES authentication if this is necessary, or by one of these functions. Authentication configuration pages are 42 and 43. The parameters of configuration is described in the card datasheet.

Factory setting of card don't require authentication for 3DES key writing into pages 44 - 47. In this case user can use function ULC_write_3des_key_no_auth, or BlockWrite for each page.

If the authentication configuration is changed to mandatory 3DES authentication for writing pages 44 - 47, and 3DES key doesn't written into card, then for authentication uses the factory 3DES key. In this case the user can use function ULC_write_3des_key_factory_key, or function ULC_ExternalAuth_PK with factory key which described in the card datasheet, and BlockWrite for each page.

If the 3DES key already written into card, and authentication for pages 44 - 47 is mandatory, then for authentication uses current 3DES key. In this case user can use function ULC_write_3des_key, or function ULC_ExternalAuth_PK with current key, and BlockWrite for each page.

Functions declaration (C language)

```
UFR_STATUS DL_API ULC_write_3des_key_no_auth
                                    (uint8_t *new_3des_key);
UFR_STATUS DL_API ULC_write_3des_key_factory_key
                                    (uint8_t *new_3des_key);
UFR_STATUS DL_API ULC_write_3des_key(uint8_t *new_3des_key,
                                     uint8_t *old_3des_key);
```

Parameters

`new_3des_key`	pointer to array of 16 bytes which contains new 2K 3DES key
`old_3des_key`	pointer to array of 16 bytes which contains current 2K 3DES key

Anti-collision support i.e. multi card reader mode

For uFR PLUS devices only (supported from firmware version 5.0.1 and library version

4.3.13)

After power on or resetting the reader it is in a “single card” mode of operation. In this mode reader can only work with one card in the field and card is selected automatically.

uFR PLUS devices can be placed in so-called “anti-collision” mode of operation using EnableAntiCollision() function call. In that mode reader can work with multiple cards in the field. Fundamental problem in a “anti-collision” mode of operation is the amount of energy that is required to power the cards in the field. Different types of cards require more or less energy. So the maximum number of cards with which reader can work simultaneously depends on specific needs for powering different cards in the field. The reader can work with up to 4 cards that have low average consumption, at a time. Cards that have low average consumption include the following models: Mifare Ultralight, Mifare Classic, Ntag series.

All the card models which supports modern cryptography mechanisms have higher power consumption. So in the case of Mifare Desfire, Mifare Ultralight C, Mifare Plus, Java Cards and other high consumption cards there should be no more than 2 cards in the reader field at a time.

EnableAntiCollision

Function description

This function puts the reader in an “anti-collision” mode of operation.

Function declaration (C language)

```
UFR_STATUS EnableAntiCollision(void);
```

DisableAntiCollision

Function description

Exits from “anti-collision” mode of operation i.e. put the reader in to “single card” mode of operation.

Function declaration (C language)

```
UFR_STATUS DisableAntiCollision(void);
```

EnumCards

Function description

If the reader is in an “anti-collision” mode of operation, this function enumerates cards which are found in the reader field. Otherwise the function returns ANTI_COLLISION_DISABLED status code.

All the calls to the ListCards(), SelectCard() and DeselectCard() work with UIDs from the actual UID list of the enumerated cards, which is obtained by the last call of this function.

Function declaration (C language)

```
UFR_STATUS EnumCards(uint8_t *lpucCardsNumber,
                     uint8_t *lpucUidListSize);
```

Parameters

lpucCardsNumber	If the function is successfully executed, the memory location on which this pointer points to, will contain a number of the enumerated cards.
lpucUidListSize	If the function is successfully executed, the memory location on which this pointer points to, will contain a UID list of the enumerated cards size in bytes.

ListCards

Function description

Before calling this function you have to call EnumCards() first.

For each UID of the cards detected in the reader field, there are 11 “UID record bytes” allocated in the list. First of those 11 bytes allocated designate actual UID length immediately followed by the exactly 10 bytes of UID (which is maximum hypothetical UID size). E.g, if the actual UID length is 4 bytes, you should ignore last 6 bytes of the UID record.

Function declaration (C language)

```
UFR_STATUS ListCards(uint8_t *aucUidList,
                     uint8_t ucUidListSize);
```

Parameters

`aucUidList`	Pointer to the memory alocated for the UID list. Before calling this function, you should alocate atleast *lpucUidListSize bytes which is returned by the prior call to EnumCards() function.
`ucUidListSize`	Size (in bytes) of the array alocated on the memory location aucUidList points to.

SelectCard

Function description

Selects one of the cards which UID is on the actual UID list of the enumerated cards. If there is any of the cards previously selected calling this function you will get an CARD_ALREADY_SELECTED status code and, in such a case, you should call DeslectCard() function prior using SelectCard(). If UID list of the enumerated cards is empty, you will get an NO_TAGS_ENUMERRATED status code.

Function declaration (C language)

```
UFR_STATUS SelectCard(const uint8_t *aucUid,
                      uint8_t ucUidSize,
                      uint8_t *lpucSelctedCardType);
```

Parameters

`aucUid`	pointer to the byte array containing UID of the card which is to be selected
`ucUidSize`	actual UID size
`lpucSelctedCardType`	pointer to byte which will contain DlogicCardType constant of the selected card, in case of successful execution of this function

DeslectCard

Function description

If the reader is in a "anti-collision" mode of operation, this function deselects currently selected card. Otherwise function returns ANTI_COLLISION_DISABLED status code.

Function declaration (C language)

```
UFR_STATUS DeslectCard(void);
```

GetAntiCollisionStatus

Function description

Calling this function you can get current anti-collision status of the reader.

Function declaration (C language)

```
UFR_STATUS GetAntiCollisionStatus(int8_t *lpcIsAntiCollEnabled,
                                  int8_t *lpcIsAnyCardSelected);
```

Parameters

lpcIsAntiCollEnabled	pointer to byte which will contain 1 if reader is in a "anti-collision" mode of operation, 0 otherwise
lpcIsAnyCardSelected	pointer to byte which will contain 1 if reader is in a "anti-collision" mode of operation and there is selected card, 0 otherwise

Functions for uFR Online

For uFR Online devices only.

EspReaderReset

Function description
Physical reset of uFR reader communication port.
Function declaration (C language)

```
UFR_STATUS EspReaderReset(void)
```

No parameters required.

EspSetDisplayData

Function description

Function enables sending data to the uFR Online. A string of data contains information about the intensity of color in each cell of the LED indication. Each cell has three LEDs (red, green and blue). For each cell of the three bytes is necessary. The first byte indicates the intensity of the green color, the second byte indicates the intensity of the red color, and the third byte indicates the intensity of blue color. For example, if the display has 2 cells, an array contains 6 bytes. Value of intensity is in range from 0 to 255. On uFR Online, there are 2 cells.

Function declaration (C language)

```
UFR_STATUS EspSetDisplayData(uint8_t *display_data,
                             uint8_t data_length, uint16_t duration);
```

Parameters

`display_data`	pointer to data array
`data_length`	number of data into array
`duration`	number of milliseconds to light.

EspChangeReaderPassword

Function description

It defines/changes password which I used for:

- Writing in EEPROM
- Setting date/time of RTC

Function declaration (C language)

```
UFR_STATUS EspChangeReaderPassword(uint8_t *old_password,
                                    uint8_t *new_password)
```

Parameters

`old_password`	pointer to the 8 bytes array containing current password
`new_password`	pointer to the 8 bytes array containing new password

EspReaderEepromWrite

Function description

Function writes array of data into EEPROM of uFR Online. Maximal length of the array is 128 bytes. Function requires a password which is 8 bytes. Factory password is “11111111” (0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31).

Function declaration (C language)

```
UFR_STATUS EspReaderEepromWrite(uint8_t *data,
                                 uint32_t address,
                                 uint32_t size,
                                 uint8_t *password);
```

Parameters

`data`	pointer to array containing data
`address`	address of first data
`size`	length of array
`password`	pointer to array containing password

EspReaderEepromRead

Function description

Function returns array of data read from EEPROM of uFR Online. Maximal length of the array is 128 bytes.

Function declaration (C language)

```
UFR_STATUS EspReaderEepromRead(uint8_t *data,
                               uint32_t address,
                               uint32_t size);
```

Parameters

`data`	pointer to array containing data from EEPROM
`address`	address of first data
`size`	length of array

EspGetReaderTime

Function description

Function returns 6 bytes array of uint8_t that represents current date and time into uFR Online RTC.

- Byte 0 represent year (current year – 2000)
- Byte 1 represent month (1 – 12)
- Byte 2 represent day of the month (1 – 31)
- Byte 3 represent hour (0 – 23)
- Byte 4 represent minute (0 – 59)
- Byte 5 represent second (0 – 59)

Function declaration (C language)

```
UFR_STATUS EspGetReaderTime(uint8_t *time);
```

Parameter

`time`	pointer to the array containing current date and time representation

EspSetReaderTime

Function description

Function sets the date and time into uFR Online RTC. Function requires the 8 bytes password entry to set date and time. Date and time are represented into a 6 bytes array in the same way as in EspGetReaderTime function. Factory password is “11111111” (0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31, 0x31).

Function declaration (C language)

```
UFR_STATUS EspSetReaderTime(uint8_t *password,
                            uint8_t *time);
```

Parameters

password	pointer to the 8 bytes array containing password
time	pointer to the 6 bytes array containing date and time representation

EspSetIOState

Function description

Function sets uFR Online IO pin state.

Function declaration (C language)

```
UFR_STATUS EspSetReaderTime(uint8_t pin,
                            uint8_t state);
```

Parameters

pin	IO pin number (1 - 6)
state	IO pin state 0 - low level, 1 - high level, 2 - input

EspGetIOState

Function description

Function returns 6 bytes array of uint8_t that represented IO pins logic level state.

Function declaration (C language)

```
UFR_STATUS EspGetReaderTime(uint8_t *state);
```

Parameters

state	pointer to the 6 bytes array containing IO pins states

EspSetTransparentReader

Function description

Function sets uFR Online transparent reader.

Function declaration (C language)

```
UFR_STATUS EspSetReaderTime(uint8_t reader);
```

Parameters

reader	Transparent reader number

EspGetReaderSerialNumber

Function description

Returns uFR Online reader serial number as a pointer to 4 byte value.

Function declaration (C language)

```
UFR_STATUS GetReaderSerialNumber(uint32_t *lpulSerialNumber)
```

Parameter

lpulSerialNumber	pointer to `lpulSerialNumber` variable. “`lpulSerialNumber` “ as result holds 4 byte serial number value.

NDEF Messages

Support for various NDEF messages is added. You can store them into a reader (for tag emulation mode) or into a card. Every function that writes an NDEF message into a card has its own read function. If you try to read an NDEF message with wrong function (for example, you stored BT MAC address as NDEF message and trying to read it with function that reads WiFi configuration), UFR_NDEF_MESSAGE_NOT_COMPATIBLE status is returned.

WriteNdefRecord_WiFi

Function description

Store WiFi configuration as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_WiFi(uint8_t ndef_storage,
                                const char *ssid,
                                uint8_t auth_type,
                                uint8_t encryption_type,
                                const char *password);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM

ssid	Pointer to the null-terminated string that should contain SSID name we want to connect to
auth_type	Authentication type: 0 - OPEN 1 - WPA Personal 2 - WPA Enterprise 3 - WPA2 Enterprise 4 - WPA2 Personal
encryption_type	Encryption type: 0 - NONE 1 - WEP 2 - TKIP 3 - AES 4 - AES/TKIP
password	Pointer to the null-terminated string that should contain password of the SSID we want to connect to

WriteNdefRecord_BT

Function description
Store BT MAC address for pairing as NDEF message into reader or into card.
Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_BT(uint8_t ndef_storage,
                              const char *bt_mac_address);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
bt_mac_address	Pointer to the null-terminated string that should contain BT MAC address for pairing in hex format (12 characters) (e.g.: “AABBCCDDEEFF”)

WriteNdefRecord_SMS

Function description
Store phone number and message data as NDEF message into reader or into card.
Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_SMS(uint8_t ndef_storage,
                               const char *phone_number,
                               const char *message);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
phone_number	Pointer to the null-terminated string that should contain phone number we want to send message to
message	Pointer to the null-terminated string that should contain message data

WriteNdefRecord_Bitcoin

Function description

Store bitcoin address, amount and donation message as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Bitcoin(uint8_t ndef_storage,
                                   const char *bitcoin_address,
                                   const char *amount,
                                   const char *message);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
bitcoin_address	Pointer to the null-terminated string that should contain bitcoin address
amount	Pointer to the null-terminated string that should contain amount (e.g.: “1.0”)
message	Pointer to the null-terminated string that should contain donation message

WriteNdefRecord_GeoLocation

Function description

Store latitude and longitude as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_GeoLocation(uint8_t ndef_storage,
                                       const char *latitude,
                                       const char *longitude);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
latitude	Pointer to the null-terminated string that should contain latitude (e.g.: “44.6229337”)
longitude	Pointer to the null-terminated string that should contain longitude (e.g.: “21.1787368”)

WriteNdefRecord_NaviDestination

Function description
Store wanted destination as NDEF message into reader or into card.
Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_NaviDestination(uint8_t ndef_storage,
                                           const char *destination);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
destination	Pointer to the null-terminated string that should contain city, street name or some other destination

WriteNdefRecord_Email

Function description
Store email message as NDEF message into reader or into card.
Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Email(uint8_t ndef_storage,
                                 const char *email_address,
                                 const char *subject,
                                 const char *message);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
email_address	Pointer to the null-terminated string that should contain recipient email address
subject	Pointer to the null-terminated string that should contain subject
message	Pointer to the null-terminated string that should contain message

WriteNdefRecord_Address

Function description

Store address (city, street name, etc) as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Address(uint8_t ndef_storage,
                                   const char *address);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
address	Pointer to the null-terminated string that should contain city name, street name, etc.

WriteNdefRecord_AndroidApp

Function description

Store android app package name as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_AndroidApp(uint8_t ndef_storage,
                                      const char *package_name);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
package_name	Pointer to the null-terminated string that should contain android app packagne name

WriteNdefRecord_Text

Function description
Store text as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Text(uint8_t ndef_storage,
                                const char *text);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
text	Pointer to the null-terminated string that should contain text

WriteNdefRecord_StreetView

Function description
Store latitude and longitude as NDEF message into reader or into card for Google StreetView.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_StreetView(uint8_t ndef_storage,
                                      const char *latitude,
                                      const char *longitude);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM

latitude	Pointer to the null-terminated string that should contain latitude (e.g.: “44.6229337”)
longitude	Pointer to the null-terminated string that should contain longitude (e.g.: “21.1787368”)

WriteNdefRecord_Skype

Function description
Store skype username as NDEF message into reader or into card for call or chat.
Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Skype(uint8_t ndef_storage,
                                 const char *user_name,
                                 uint8_t action);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
user_name	Pointer to the null-terminated string that should contain skype username
action	Action type: call - 0 chat - 1

WriteNdefRecord_Whatsapp

Function description
Store Whatsapp message as NDEF message into reader or into card.
Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Whatsapp(uint8_t ndef_storage,
                                    const char *message);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
message	Pointer to the null-terminated string that should contain Whatsapp message

WriteNdefRecord_Viber

Function description
Store Viber message as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Viber(uint8_t ndef_storage,
                                 const char *message);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
message	Pointer to the null-terminated string that should contain Viber message

WriteNdefRecord_Contact

Function description
Store phone contact as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Contact(uint8_t ndef_storage,
                                   const char *name,
                                   const char *company,
                                   const char *address,
                                   const char *phone,
                                   const char *email,
                                   const char *website);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
name	Pointer to the null-terminated string that should contain contact display name
company	Pointer to the null-terminated string that should contain contact company name
address	Pointer to the null-terminated string that should contain contact residental address
phone	Pointer to the null-terminated string that should contain contact phone number

email	Pointer to the null-terminated string that should contain contact email address
website	Pointer to the null-terminated string that should contain contact website

WriteNdefRecord_Phone

Function description
Store phone_number as NDEF message into reader or into card.

Function declaration (C language)

```
UFR_STATUS WriteNdefRecord_Phone(uint8_t ndef_storage,
                                 const char *phone_number);
```

Parameters

ndef_storage	Store NDEF into: reader - 0, card - 1 From library 5.0.31 and firmware 5.0.33 2 - reader RAM
phone_number	Pointer to the null-terminated string that should contain phone_number

ReadNdefRecord_WiFi

Function description
Reads NDEF WiFi configuration from card..

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_WiFi(char *ssid,
                               char *auth_type,
                               char *encryption_type,
                               char *password);
```

Parameters

ssid	Pointer to char array containing SSID name
auth_type	Pointer to char array containing authentication type
encryption_type	Pointer to char array containing encryption type
password	Pointer to char array containing password

ReadNdefRecord_BT

Function description

Reads NDEF Bluetooth MAC address for pairing from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Bluetooth(char *bt_mac_address);
```

Parameters

bt_mac_address	Pointer to char array containing Bluetooth MAC address

ReadNdefRecord_SMS

Function description

Reads NDEF phone number and message from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_SMS(char *phone_number,
                              char *message);
```

Parameters

phone_number	Pointer to char array containing phone number
message	Pointer to char array containing message

ReadNdefRecord_Bitcoin

Function description

Reads NDEF bitcoin address, amount and donation message from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Bitcoin(char *bitocin_address,
                                  char *amount,
                                  char *message);
```

Parameters

bitcoin_address	Pointer to char array containing bitcoin_address

amount	Pointer to char array containing bitcoin amount
message	Pointer to char array containing donation message

ReadNdefRecord_GeoLocation

Function description

Reads NDEF latitude and longitude from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_GeoLocation(char *latitude,
                                      char *longitude);
```

Parameters

latitude	Pointer to char array containing latitude
longitude	Pointer to char array containing longitude

ReadNdefRecord_NaviDestination

Function description

Reads NDEF navigation destination from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_NaviDestination(char *destination);
```

Parameters

destination	Pointer to char array containing destination

ReadNdefRecord_Email

Function description

Reads NDEF email address, subject and message from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Email(char *email_address,
                                char *subject,
                                char *message);
```

Parameters

email_address	Pointer to char array containing recipient email address
subject	Pointer to char array containing subject
message	Pointer to char array containing message

ReadNdefRecord_Address

Function description
Reads NDEF address (city, street name,etc) from card.
Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Address(char *address);
```

Parameters

address	Pointer to char array containing address

ReadNdefRecord_Text

Function description
Reads NDEF text from card.
Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Text(char *text);
```

Parameters

text	Pointer to char array containing text

ReadNdefRecord_StreetView

Function description
Reads NDEF latitude and longitude for Google StreetView from card.
Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_StreetView(char *latitude,
                                     char *longitude);
```

Parameters

latitude	Pointer to char array containing latitude
longitude	Pointer to char array containing longitude

ReadNdefRecord_Skype

Function description

Reads NDEF skype username and action from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Skype(char *user_name,
                                char *action);
```

Parameters

user_name	Pointer to char array containing Skype username
action	Pointer to char array containing Skype action (“call” or “chat”)

ReadNdefRecord_Whatsapp

Function description

Reads NDEF Whatsapp message from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Whatsapp(char *message);
```

Parameters

message	Pointer to char array containing Whatsapp message

ReadNdefRecord_Viber

Function description

Reads NDEF Viber message from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Viber(char *message);
```

Parameters

message	Pointer to char array containing Viber message

ReadNdefRecord_Contact

Function description

Reads NDEF phone contact from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Contact(char *vCard);
```

Parameters

vCard	Pointer to char array containing phone contact data

ReadNdefRecord_Phone

Function description

Reads NDEF phone number from card.

Function declaration (C language)

```
UFR_STATUS ReadNdefRecord_Phone(char *phone_number);
```

Parameters

phone_number	Pointer to char array containing phone number

NT4H cards functions

From library version 5.0.29. and firmware version 5.0.32

Supported cards are NT4H1321 (NTAG 413 DNA), NT4H2421Gx (NTAG 424 DNA), and NT4H2421Tx (NTAG 424 DNA TT) card.

NTAG 424 DNA is fully compliant with the NFC Forum Type 4 Tag IC specification (Certification ID: 58562), with the contactless proximity protocol according to ISO/IEC14443-4 and the ISO/IEC 7816-4 based file system and command frames.

NTAG 424 DNA TT comes with smart status awareness, detecting the status of a tamper loop.

nt4h_set_global_parameters

Function description

Function sets file number, key number, and communication mode, before the using functions for reading and writing data into cards which are used for NTAG 2xx cards. This makes it possible to use existing functions for the block and linear reading and writing.

Function declaration (C language)

```
UFR_STATUS nt4h_set_global_parameters(uint8_t file_no,
                                   uint8_t key_no,
                                   uint8_t communication_mode);
```

Parameters

`file_no`	NTAG 413 - 1 or 2 NTAG 424 and NTAG 424 TT - 1 to 3
`key_no`	NTAG 413 - 0 to 2 NTAG 424 and NTAG 424 TT - 0 to 4
`communication_mode`	0 - plain, 1 - macked, 3 - enciphered

nt4h_change_standard_file_settings
nt4h_change_standard_file_settings_pk

Function description

The function changes the access parameters of an existing standard data file. The communication mode can be either plain or enciphered based on current access rights of the file, so current communication mode must be entered. Access rights are similar for Desfire cards.

Function declaration (C language)

```
UFR_STATUS nt4h_change_standard_file_settings_pk(
                              IN uint8_t *aes_key_ext,
                              uint8_t file_no,
                              uint8_t key_no,
                              uint8_t curr_communication_mode,
                              uint8_t new_communication_mode,
                              uint8_t read_key_no,
                              uint8_t write_key_no,
                              uint8_t read_write_key_no,
                              uint8_t change_key_no);
UFR_STATUS DL_API nt4h_change_standard_file_settings(
                              uint8_t aes_key_no,
                              uint8_t file_no,
                              uint8_t key_no,
                              uint8_t curr_communication_mode,
                              uint8_t new_communication_mode,
                              uint8_t read_key_no,
                              uint8_t write_key_no,
                              uint8_t read_write_key_no,
                              uint8_t change_key_no);
```

Parameters

`*aes_key_ext`	pointer to array contained AES key
`aes_key_no`	ordinal number of AES key into reader (0 - 15)
`file_no`	NTAG 413 - 1 or 2 NTAG 424 and NTAG 424 TT - 1 to 3
`key_no`	current change key number NTAG 413 - 0 to 2 NTAG 424 and NTAG 424 TT - 0 to 4
`curr_communication_mode`	current communication mode 0 - plain, 1 - macked, 3 - enciphered
`new_communication_mode`	new communication mode 0 - plain, 1 - macked, 3 - enciphered
`read_key_no`	reading key number
`write_key_no`	writing key number
`read_write_key_no`	reading and writing key number
`change_key_no`	new change key number

nt4h_change_sdm_file_settings
nt4h_change_sdm_file_settings_pk

Function description

Function allows change parameters for secure dynamic messaging file, or change file type from standard data file to secure dynamic messaging file. Due to the large number of parameters, the function is separated from the function for creating a standard data file.

Function declaration (C language)

```
UFR_STATUS nt4h_change_sdm_file_settings_pk(
                         IN uint8_t *aes_key_ext,
                         uint8_t file_no,
                         uint8_t key_no,
                         uint8_t curr_communication_mode,
                         uint8_t new_communication_mode,
                         uint8_t read_key_no,
                         uint8_t write_key_no,
                         uint8_t read_write_key_no,
                         uint8_t change_key_no,
                         uint8_t uid_enable,
                         uint8_t read_ctr_enable,
                         uint8_t read_ctr_limit_enable,
                         uint8_t enc_file_data_enable,
                         uint8_t meta_data_key_no,
                         uint8_t file_data_read_key_no,
                         uint8_t read_ctr_key_no,
                         uint32_t uid_offset,
                         uint32_t read_ctr_offset,
                         uint32_t picc_data_offset,
                         uint32_t mac_input_offset,
                         uint32_t enc_offset,
                         uint32_t enc_length,
                         uint32_t mac_offset,
                         uint32_t read_ctr_limit);
UFR_STATUS nt4h_change_sdm_file_settings(
                         uint8_t aes_key_no,
                         uint8_t file_no,
                         uint8_t key_no,
                         uint8_t curr_communication_mode,
                         uint8_t new_communication_mode,
                         uint8_t read_key_no,
                         uint8_t write_key_no,
                         uint8_t read_write_key_no,
                         uint8_t change_key_no,
                         uint8_t uid_enable,
                         uint8_t read_ctr_enable,
                         uint8_t read_ctr_limit_enable,
                         uint8_t enc_file_data_enable,
                         uint8_t meta_data_key_no,
                         uint8_t file_data_read_key_no,
                         uint8_t read_ctr_key_no,
                         uint32_t uid_offset,
                         uint32_t read_ctr_offset,
                         uint32_t picc_data_offset,
                         uint32_t mac_input_offset,
                         uint32_t enc_offset,
                         uint32_t enc_length,
                         uint32_t mac_offset,
                         uint32_t read_ctr_limit);
```

Parameters

***aes_key_ext**	pointer to array contained AES key
aes_key_no	ordinal number of AES key into reader (0 - 15)
file_no	NTAG 413 - 1 or 2 NTAG 424 - 1 to 3
key_no	current change key number NTAG 413 - 0 to 2 NTAG 424 - 0 to 4
curr_communication_mode	current communication mode 0 - plain, 1 - macked, 3 - enciphered
new_communication_mode	new communication mode 0 - plain
read_key_no	reading key number (14 free access)
write_key_no	writing key number
read_write_key_no	reading and writing key number
change_key_no	new change key number
uid_enable	UID mirroring (0 - disabled, 1 - enabled)
read_ctr_enable	SDM reading counter (0 - disabled, 1 - enabled)
read_ctr_limit_enable	SDM reading counter limit (0 - disabled, 1 - enabled)
enc_file_data_enable	using encrypted part of file data (NTAG 424 only) (0 - disabled, 1 - enabled)
meta_data_key_no	key number for PICC data (UID and SDM read ctr) encryption 0 - 4 (NTAG 424 only), 14 no encryption, 15 no PICC data
file_data_read_key_no	key number for MAC and encrypted part of file data (NTAG 424 only) 0 - 2 or 0 - 4, 15 no MAC
read_ctr_key_no	key number for SDM reading counter retrieving 0 - 2 or 0 - 4, 14 free, 15 no access
uid_offset	mirror position of UID if PICC data aren’t encrypted
read_ctr_offset	mirror position of SDM reading counter if PICC data aren’t encrypted
picc_data_offset	mirror position of encrypted PICC data (NTAG 424 only)
mac_input_offset	offset in the file where the SDM MAC computation starts
enc_offset	mirror position of encrypted part of file data (NTAG 424 only)

`enc_length`	length of encrypted part of file data (NTAG 424 only)
`mac_offset`	mirror position of SDM MAC
`read_crt_limit`	value of SDM reading counter limit

nt4h_tt_change_sdm_file_settings
nt4h_tt_change_sdm_file_settings_pk

Function description

NTAG 424 TT only. From library version 5.0.43 and firmware version 5.0.43.

Function allows change parameters for secure dynamic messaging file, or change file type from standard data file to secure dynamic messaging file. Due to the large number of parameters, the function is separated from the function for creating a standard data file.

Function declaration (C language)

```
UFR_STATUS nt4h_tt_change_sdm_file_settings_pk(
                         IN uint8_t *aes_key_ext,
                         uint8_t file_no,
                         uint8_t key_no,
                         uint8_t curr_communication_mode,
                         uint8_t new_communication_mode,
                         uint8_t read_key_no,
                         uint8_t write_key_no,
                         uint8_t read_write_key_no,
                         uint8_t change_key_no,
                         uint8_t uid_enable,
                         uint8_t read_ctr_enable,
                         uint8_t read_ctr_limit_enable,
                         uint8_t enc_file_data_enable,
                         uint8_t meta_data_key_no,
                         uint8_t file_data_read_key_no,
                         uint8_t read_ctr_key_no,
                         uint32_t uid_offset,
                         uint32_t read_ctr_offset,
                         uint32_t picc_data_offset,
                         uint32_t mac_input_offset,
                         uint32_t enc_offset,
                         uint32_t enc_length,
                         uint32_t mac_offset,
                         uint32_t read_ctr_limit,
                         uint8_t tt_status_enable,
                         uint32_t tt_status_offset);
UFR_STATUS nt4h_tt_change_sdm_file_settings(
                         uint8_t aes_key_no,
                         uint8_t file_no,
                         uint8_t key_no,
                         uint8_t curr_communication_mode,
                         uint8_t new_communication_mode,
                         uint8_t read_key_no,
                         uint8_t write_key_no,
                         uint8_t read_write_key_no,
                         uint8_t change_key_no,
                         uint8_t uid_enable,
                         uint8_t read_ctr_enable,
                         uint8_t read_ctr_limit_enable,
                         uint8_t enc_file_data_enable,
                         uint8_t meta_data_key_no,
                         uint8_t file_data_read_key_no,
                         uint8_t read_ctr_key_no,
                         uint32_t uid_offset,
                         uint32_t read_ctr_offset,
                         uint32_t picc_data_offset,
                         uint32_t mac_input_offset,
                         uint32_t enc_offset,
                         uint32_t enc_length,
                         uint32_t mac_offset,
                         uint32_t read_ctr_limit,
                         uint8_t tt_status_enable,
                         uint32_t tt_status_offset);
```

Parameters

`*aes_key_ext`	pointer to array contained AES key
`aes_key_no`	ordinal number of AES key into reader (0 - 15)
`file_no`	1 - 3
`key_no`	current change key number 0 - 4
`curr_communication_mode`	current communication mode 0 - plain, 1 - macked, 3 - enciphered
`new_communication_mode`	new communication mode 0 - plain
`read_key_no`	reading key number (14 free access)
`write_key_no`	writing key number
`read_write_key_no`	reading and writing key number
`change_key_no`	new change key number
`uid_enable`	UID mirroring (0 - disabled, 1 - enabled)
`read_ctr_enable`	SDM reading counter (0 - disabled, 1 - enabled)
`read_ctr_limit_enable`	SDM reading counter limit (0 - disabled, 1 - enabled)
`enc_file_data_enable`	using encrypted part of file data (0 - disabled, 1 - enabled)
`meta_data_key_no`	key number for PICC data (UID and SDM read ctr) encryption 0 - 4, 14 no encryption, 15 no PICC data
`file_data_read_key_no`	key number for MAC and encrypted part of file data 0 - 4, 15 no MAC
`read_ctr_key_no`	key number for SDM reading counter retrieving 0 - 4, 14 free, 15 no access
`uid_offset`	mirror position of UID if PICC data aren't encrypted
`read_ctr_offset`	mirror position of SDM reading counter if PICC data aren't encrypted
`picc_data_offset`	mirror position of encrypted PICC data
`mac_input_offset`	offset in the file where the SDM MAC computation starts
`enc_offset`	mirror position of encrypted part of file data
`enc_length`	length of encrypted part of file data
`mac_offset`	mirror position of SDM MAC

`read_crt_limit`	value of SDM reading counter limit
`tt_status_enable`	tag tamper status mirroring (0 - disabled, 1 - enabled)
`tt_status_offset`	mirror position of tag tamper status

nt4h_get_file_settings

Function description

Function returns file settings.

Function declaration (C language)

```
UFR_STATUS nt4h_get_file_settings(uint8_t file_no,
                              VAR uint8_t *file_type,
                              VAR uint8_t *communication_mode,
                              VAR uint8_t *sdm_enable,
                              VAR uint32_t *file_size,
                              VAR uint8_t *read_key_no,
                              VAR uint8_t *write_key_no,
                              VAR uint8_t *read_write_key_no,
                              VAR uint8_t *change_key_no,
                              VAR uint8_t *uid_enable,
                              VAR uint8_t *read_ctr_enable,
                              VAR uint8_t *read_ctr_limit_enable,
                              VAR uint8_t *enc_file_data_enable,
                              VAR uint8_t *meta_data_key_no,
                              VAR uint8_t *file_data_read_key_no,
                              VAR uint8_t *read_ctr_key_no,
                              VAR uint32_t *uid_offset,
                              VAR uint32_t *read_ctr_offset,
                              VAR uint32_t *picc_data_offset,
                              VAR uint32_t *mac_input_offset,
                              VAR uint32_t *enc_offset,
                              VAR uint32_t *enc_length,
                              VAR uint32_t *mac_offset,
                              VAR uint32_t *read_ctr_limit);
```

Parameters

file_no	NTAG 413 - 1 or 2 NTAG 424 - 1 to 3
***file_type**	0 - standard data file
***communication_mode**	communication mode 0 - plain, 1 - macked, 3 - enciphered
***sdm_enable**	0 - SDM disabled, 1 - SDM enabled
***read_key_no**	reading key number
***write_key_no**	writing key number
***read_write_key_no**	reading and writing key number
***change_key_no**	new change key number
***uid_enable**	UID mirroring (0 - disabled, 1 - enabled)
***read_ctr_enable**	SDM reading counter (0 - disabled, 1 - enabled)
***read_ctr_limit_enable**	SDM reading counter limit (0 - disabled, 1 - enabled)
***enc_file_data_enable**	using encrypted part of file data (NTAG 424 only) (0 - disabled, 1 - enabled)
***meta_data_key_no**	key number for PICC data (UID and SDM read ctr) encryption 0 - 4 (NTAG 424 only), 14 no encryption, 15 no PICC data
***file_data_read_key_no**	key number for MAC and encrypted part of file data (NTAG 424 only) 0 - 2 or 0 - 4, 15 no MAC
***read_ctr_key_no**	key number for SDM reading counter retrieving 0 - 2 or 0 - 4, 14 free, 15 no access
***uid_offset**	mirror position of UID if PICC data aren't encrypted
***read_ctr_offset**	mirror position of SDM reading counter if PICC data aren't encrypted
***picc_data_offset**	mirror position of encrypted PICC data (NTAG 424 only)
***mac_input_offset**	offset in the file where the SDM MAC computation starts
***enc_offset**	mirror position of encrypted part of file data (NTAG 424 only)
***enc_length**	length of encrypted part of file data (NTAG 424 only)
***mac_offset**	mirror position of SDM MAC
***read_crt_limit**	value of SDM reading counter limit

nt4h_tt_get_file_settings

Function description
NTAG 424 TT only. From library version 5.0.43 and firmware version 5.0.43.

Function returns file settings.

Function declaration (C language)

```
UFR_STATUS nt4h_tt_get_file_settings(uint8_t file_no,
                              VAR uint8_t *file_type,
                              VAR uint8_t *communication_mode,
                              VAR uint8_t *sdm_enable,
                              VAR uint32_t *file_size,
                              VAR uint8_t *read_key_no,
                              VAR uint8_t *write_key_no,
                              VAR uint8_t *read_write_key_no,
                              VAR uint8_t *change_key_no,
                              VAR uint8_t *uid_enable,
                              VAR uint8_t *read_ctr_enable,
                              VAR uint8_t *read_ctr_limit_enable,
                              VAR uint8_t *enc_file_data_enable,
                              VAR uint8_t *meta_data_key_no,
                              VAR uint8_t *file_data_read_key_no,
                              VAR uint8_t *read_ctr_key_no,
                              VAR uint32_t *uid_offset,
                              VAR uint32_t *read_ctr_offset,
                              VAR uint32_t *picc_data_offset,
                              VAR uint32_t *mac_input_offset,
                              VAR uint32_t *enc_offset,
                              VAR uint32_t *enc_length,
                              VAR uint32_t *mac_offset,
                              VAR uint32_t *read_ctr_limit,
                              VAR uint8_t *tt_status_enable,
                              VAR uint32_t *tt_status_offset);
```

Parameters

file_no	NTAG 413 - 1 or 2 NTAG 424 - 1 to 3
***file_type**	0 - standard data file
***communication_mode**	communication mode 0 - plain, 1 - macked, 3 - enciphered
***sdm_enable**	0 - SDM disabled, 1 - SDM enabled
***read_key_no**	reading key number
***write_key_no**	writing key number
***read_write_key_no**	reading and writing key number
***change_key_no**	new change key number
***uid_enable**	UID mirroring (0 - disabled, 1 - enabled)
***read_ctr_enable**	SDM reading counter (0 - disabled, 1 - enabled)
***read_ctr_limit_enable**	SDM reading counter limit (0 - disabled, 1 - enabled)
***enc_file_data_enable**	using encrypted part of file data (NTAG 424 only) (0 - disabled, 1 - enabled)
***meta_data_key_no**	key number for PICC data (UID and SDM read ctr) encryption 0 - 4 (NTAG 424 only), 14 no encryption, 15 no PICC data
***file_data_read_key_no**	key number for MAC and encrypted part of file data (NTAG 424 only) 0 - 2 or 0 - 4, 15 no MAC
***read_ctr_key_no**	key number for SDM reading counter retrieving 0 - 2 or 0 - 4, 14 free, 15 no access
***uid_offset**	mirror position of UID if PICC data aren't encrypted
***read_ctr_offset**	mirror position of SDM reading counter if PICC data aren't encrypted
***picc_data_offset**	mirror position of encrypted PICC data (NTAG 424 only)
***mac_input_offset**	offset in the file where the SDM MAC computation starts
***enc_offset**	mirror position of encrypted part of file data (NTAG 424 only)
***enc_length**	length of encrypted part of file data (NTAG 424 only)
***mac_offset**	mirror position of SDM MAC
***read_crt_limit**	value of SDM reading counter limit

`*tt_status_enable`	tag tamper status (0 - disabled, 1 - enabled)
`*tt_status_offset`	mirror position of tag tamper status

nt4h_set_rid
nt4h_set_rid_pk

Function description

Function enables card Random ID. Authentication with application master key (key number 0) required.

Warning. This operation is ireversibile.

Function declaration (C language)

```
UFR_STATUS nt4h_set_rid_pk(IN uint8_t *aes_key_ext);
UFR_STATUS nt4h_set_rid(uint8_t aes_key_no);
```

Parameters

`*aes_key_ext`	pointer to array contained AES key
`aes_key_no`	ordinal number of AES key into reader (0 - 15)

nt4h_get_uid
nt4h_get_uid_pk

Function description

Function returns card UID if Random ID activated. Valid authentication is required.

Function declaration (C language)

```
UFR_STATUS nt4h_get_uid(uint8_t auth_key_no,
                              uint8_t key_no,
                              OUT uint8_t *uid);
UFR_STATUS nt4h_get_uid_pk(IN uint8_t *auth_key,
                              uint8_t key_no,
                              OUT uint8_t *uid);
```

Parameters

`*auth_key`	pointer to array contained AES key
`auth_key_no`	ordinal number of AES key into reader (0 - 15)
`*uid`	pointer to array contained UID

nt4h_change_key
nt4h_change_key_pk

Function description

Function changes AES key. Authentication with the application master key is required.

Function declaration (C language)

```
UFR_STATUS nt4h_change_key_pk(IN uint8_t *auth_key,
                              uint8_t key_no,
                              IN uint8_t *new_key,
                              IN uint8_t *old_key);
UFR_STATUS DL_API nt4h_change_key(uint8_t auth_key_no,
                              uint8_t key_no,
                              IN uint8_t *new_key,
                              IN uint8_t *old_key);
```

Parameters

`*auth_key`	pointer to array contained AES key
`auth_key_no`	ordinal number of AES key into reader (0 - 15)
`key_no`	key number 0 - 2 or 0 - 4
`*new_key`	pointer to array contained new AES key
`*old_key`	pointer to array contained current AES key

nt4h_get_sdm_ctr
nt4h_get_sdm_ctr_pk
nt4h_get_sdm_ctr_no_auth

Function description

Function supports retrieving of the current values of SDM reading counter.

Function declaration (C language)

```
UFR_STATUS nt4h_get_sdm_ctr_pk(IN uint8_t *auth_key,
                              uint8_t file_no,
                              uint8_t key_no,
                              VAR uint32_t *sdm_read_ctr);
UFR_STATUS nt4h_get_sdm_ctr(uint8_t auth_key_no,
                              uint8_t file_no,
                              uint8_t key_no,
                              VAR uint32_t *sdm_read_ctr);
UFR_STATUS nt4h_get_sdm_ctr_no_auth(uint8_t file_no,
                              VAR uint32_t *sdm_read_ctr);
```

Parameters

***auth_key**	pointer to array contained AES key
auth_key_no	ordinal number of AES key into reader (0 - 15)
file_no	file number of SDM file (2)
key_no	key number 0 - 2 or 0 - 4
***sdm_read_ctr**	pointer to value of SDM reading counter

nt4h_check_sdm_mac

Function description

Helper function for the MAC of SDM checking. Users need to know the SDM counter, UID and AES key for file data read.

Function declaration (C language)

```
UFR_STATUS nt4h_check_sdm_mac(uint32_t smd_read_counter,
                              IN uint8_t *uid,
                              IN uint8_t *auth_key,
                              IN uint8_t *mac_in_data,
                              IN uint8_t mac_in_len,
                              IN uint8_t *sdm_mac);
```

Parameters

sdm_read_counter	value of SDM reading counter
***uid**	pointer to array contained 7 bytes UID
***auth_key**	pointer to array contained AES file data read key
***mac_in_data**	data from mac_input_offset to mac_offset
mac_in_len	mac_input_offset - mac_offset
***sdm_mac**	pointer to array contained 8 bytes SDM MAC

nt4h_decrypt_sdm_enc_file_data

Function description

Helper function for decryption of encrypted file data. Users need to know the SDM counter, UID and AES key for file data read.

Function declaration (C language)

```
UFR_STATUS nt4h_decrypt_sdm_enc_file_data(uint32_t smd_read_counter,
                                          IN uint8_t *uid,
                                          IN uint8_t *auth_key,
                                          IN uint8_t *enc_file_data,
                                          IN uint8_t enc_file_data_len);
```

Parameters

`sdm_read_counter`	value of SDM reading counter
`*uid`	pointer to array contained 7 bytes UID
`*auth_key`	pointer to array contained AES file data read key
`*enc_file_data`	pointer to array contained encrypted part of file data
`enc_file_data_len`	length of encrypted part of file data

nt4h_decrypt_picc_data

Function description

Helper function for decryption of encrypted PICC data. Function returns UID and SDM reading counter. Users need to know the AES key for metadata read (PICC data).

Function declaration (C language)

```
UFR_STATUS nt4h_decrypt_picc_data(IN uint8_t *picc_data,
                                  IN uint8_t *auth_key,
                                  IN uint8_t *picc_data_tag,
                                  IN uint8_t *uid,
                                  IN uint32_t *smd_read_cnt);
```

Parameters

`*picc_data`	pointer to array contained encrypted PICC data
`*auth_key`	pointer to array contained AES meta data read key

`*picc_data_tag`	if bit 7 set exist UID mirroring
	if bit 6 set exist SDM reading counter

`*uid`	pointer to array contained 7 bytes UID
`*sdm_read_cnt`	pointer to value of SDM reading counter

nt4h_enable_tt_pk
nt4h_enable_tt

Function description

NTAG 424 TT only. From library version 5.0.43 and firmware version 5.0.43.

Function enabling tag tamper feature. Authentication with application master key (key number 0) required.

Warning. Enabling the Tag Tamper feature is permanent, it cannot be disabled once enabled.

Function declaration (C language)

```
UFR_STATUS nt4h_enable_tt_pk(IN uint8_t *aes_key_ext,
                             uint8_t tt_status_key_no);
UFR_STATUS nt4h_enable_tt(uint8_t aes_key_no,
                             uint8_t tt_status_key_no);
```

Parameters

`*aes_key_ext`	pointer to array contained AES key
`aes_key_no`	ordinal number of AES key into reader (0 - 15)
`tt_status_key_no`	0 - 4, 14 free access

nt4h_get_tt_status_pk
nt4h_get_tt_status
nt4h_get_tt_status_no_auth

Function description

NTAG 424 TT only. From library version 5.0.43 and firmware version 5.0.43.

Function supports retrieving of the permanent and current Tag Tamper Status.

Function declaration (C language)

```
UFR_STATUS nt4h_get_tt_status_pk(IN uint8_t *aes_key_ext,
                              uint8_t key_no,
                              VAR uint8_t *tt_perm_status,
                              VAR uint8_t *tt_curr_status);
UFR_STATUS nt4h_get_tt_status(uint8_t aes_key_nr,
                              uint8_t key_no,
                              VAR uint8_t *tt_perm_status,
                              VAR uint8_t *tt_curr_status);
UFR_STATUS nt4h_get_tt_status_no_auth(VAR uint8_t *tt_perm_status,
                              VAR uint8_t *tt_curr_status);
```

Parameters

`*aes_key_ext`	pointer to array contained AES key
`aes_key_no`	ordinal number of AES key into reader (0 - 15)
`key_no`	tag tamper status key number 0 - 4
`*tt_perm_status`	tag tamper permanent status: I - invalid status, feature not activated C - tamper seal closed O - tamper seal opened
`*tt_curr_status`	tag tamper permanent status: I - invalid status, feature not activated C - tamper seal closed O - tamper seal opened

nt4h_rid_read_ecc_signature_pk
nt4h_rid_read_ecc_signature

Function description

From library version 5.0.43 and firmware version 5.0.43.

Function retrieves the asymmetric originality signature based on an asymmetric cryptographic algorithm Elliptic Curve Cryptography Digital Signature Algorithm (ECDSA) when the Random ID is activated. Authentication with valid key required.

Function declaration (C language)

```
UFR_STATUS nt4h_rid_read_ecc_signature_pk(IN uint8_t *auth_key,
                                          uint8_t key_no,
                                          OUT uint8_t *uid,
                                          OUT uint8_t *ecc_signature,
                                          VAR uint8_t *dlogic_card_type);
UFR_STATUS nt4h_rid_read_ecc_signature(uint8_t auth_key_nr,
                                          uint8_t key_no,
                                          OUT uint8_t *uid,
                                          OUT uint8_t *ecc_signature,
                                          OUT uint8_t *dlogic_card_type);
```

Parameters

*auth_key	pointer to array contained AES key
auth_key_nr	ordinal number of AES key into reader (0 - 15)
key_no	0 - 4
*uid	7 bytes UID length
*ecc_signature	56 bytes ECC signature
*dlogic_card_type	

Miscellaneous functions

CheckUidChangeable

Function description

Function tries to change the UID on the card. On some cards (e.g. Magic Classic) changing UID is possible. If the tested card is that type of card, then the function returns UFR_OK.

Function declaration (C language)

```
UFR_STATUS CheckUidChangeable(void);
```

ReaderRfReset

Function description

Function reset RF field at the reader. The RF field will be off, and then on after 50ms.

Function declaration (C language)

```
UFR_STATUS ReaderRfReset(void);
```

ReaderRfOn

From library version 5.0.48, and firmware version 5.0.51.

Function description
Function switch on RF field at the reader. For proper functionality the reader must be in the multi card mode.

Function declaration (C language)
```
UFR_STATUS ReaderRfOn(void);
```

ReaderRfOff

From library version 5.0.48, and firmware version 5.0.51.

Function description
Function switch off RF field at the reader. For proper functionality the reader must be in the multi card mode. The RF field can be switched on by functions ReaderRfOn, EnumCards, or DisableAnticolision.

Function declaration (C language)
```
UFR_STATUS ReaderRfOff(void);
```

GetReaderStatus

From library version 5.0.31 and firmware version 5.0.33

Function description
Function returns various reader states. The reader states are defined into following structures. This function is useful for checking if the reader is still in emulation mode after calling the TagEmulationStartRam() function.

```
typedef enum E_EMULATION_MODES {
     TAG_EMU_DISABLED,
     TAG_EMU_DEDICATED,
     TAG_EMU_COMBINED,
     TAG_EMU_AUTO_AD_HOC
}emul_modes_t;

typedef enum E_EMULATION_STATES
{
     EMULATION_NONE,
     EMULATION_IDLE,
     EMULATION_AUTO_COLL,
     EMULATION_ACTIVE,
     EMULATION_HALT,
     EMULATION_POWER_OFF
}emul_states_t;

typedef enum E_PCD_MGR_STATES
{
     PCD_MGR_NO_RF_GENERATED,
     PCD_MGR_14443A_POLLING,
     PCD_MGR_14443A_SELECTED,
     PCD_MGR_CE_DEDICATED,
     PCD_MGR_CE_COMBO_START,
     PCD_MGR_CE_COMBO,
     PCD_MGR_CE_COMBO_IN_FIELD
}pcd_states_t;
```

Function declaration (C language)

```
UFR_STATUS GetReaderStatus(pcd_states_t *state,
                           emul_modes_t *emul_mode,
                           emul_states_t *emul_state,
                           uint8_t *sleep_mode);
```

Parameters

state	- normal working mode states are PCD_MGR_NO_RF_GENERATED or PCD_MGR_14443A_POLLING or PCD_MGR_14443A_SELECTED. - NTAG emulation mode state is PCD_MGR_CE_DEDICATED
emul_mode	- normal working mode state is TAG_EMU_DISABLED - NTAG emulation mode state is TAG_EMU_DEDICATED
emul_state	state from structure emul_states_t
sleep_mode	0 - reader is in normal or emulation mode 1 - reader is in sleep mode

GetAtqaSak

From library version 5.0.36 and firmware version 5.0.37

Function description

Function returns ATQA and SAK (ISO 14443-3) of selected card.

Function declaration (C language)

```
UFR_STATUS DL_API GetAtqaSak(uint16_t *atqa,
                             uint8_t *sak);
```

Parameters

atqa	pointer to variable which contain ATQA
sak	pointer to variable which contain SAK

ReadTTStatus

From library version 5.0.59 and firmware version 5.0.60

Function description

Function provides the information about the tag tamper status which is detected when the NTAG 213 TT is powered by an RF field.

Function declaration (C language)

```
UUFR_STATUS DL_API ReadTTStatus(uint8_t *tt_message,
                                uint8_t *tt_status);
```

Parameters

`tt_message`	4 byte Tag Tamper message. “0000” is returned, if the NTAG 213 TT has never detected the Tag Tamper as opened during the startup. If the NTAG 213 TT has once detected the tag tamper wire as opened, it returns the data which have been programmed in page 45 (TT_MESSAGE)
`tt_status`	status of the tag tamper wire detected during startup. “C” if Tag Tamper was closed at current startup “O” if Tag Tamper was open at current startup “I” if Tag Tamper measurement was incorrect

Appendix: STATUS CODES (DL_STATUS result)

UFR_OK	0x00
UFR_COMMUNICATION_ERROR	0x01
UFR_CHKSUM_ERROR	0x02
UFR_READING_ERROR	0x03
UFR_WRITING_ERROR	0x04
UFR_BUFFER_OVERFLOW	0x05
UFR_MAX_ADDRESS_EXCEEDED	0x06
UFR_MAX_KEY_INDEX_EXCEEDED	0x07
UFR_NO_CARD	0x08
UFR_COMMAND_NOT_SUPPORTED	0x09
UFR_FORBIDEN_DIRECT_WRITE_IN_SECTOR_TRAILER	0x0A
UFR_ADDRESSED_BLOCK_IS_NOT_SECTOR_TRAILER	0x0B
UFR_WRONG_ADDRESS_MODE	0x0C
UFR_WRONG_ACCESS_BITS_VALUES	0x0D
UFR_AUTH_ERROR	0x0E
UFR_PARAMETERS_ERROR	0x0F
UFR_MAX_SIZE_EXCEEDED	0x10
UFR_UNSUPPORTED_CARD_TYPE	0x11
UFR_COUNTER_ERROR	0x12
UFR_WRITE_VERIFICATION_ERROR	0x70
UFR_BUFFER_SIZE_EXCEEDED	0x71
UFR_VALUE_BLOCK_INVALID	0x72
UFR_VALUE_BLOCK_ADDR_INVALID	0x73
UFR_VALUE_BLOCK_MANIPULATION_ERROR	0x74
UFR_WRONG_UI_MODE	0x75
UFR_KEYS_LOCKED	0x76
UFR_KEYS_UNLOCKED	0x77

UFR_WRONG_PASSWORD	0x78
UFR_CAN_NOT_LOCK_DEVICE	0x79
UFR_CAN_NOT_UNLOCK_DEVICE	0x7A
UFR_DEVICE_EEPROM_BUSY	0x7B
UFR_RTC_SET_ERROR	0x7C
ANTI_COLLISION_DISABLED	0x7D
NO_TAGS_ENUMERRATED	0x7E
CARD_ALREADY_SELECTED	0x7F
UFR_COMMUNICATION_BREAK	0x50
UFR_NO_MEMORY_ERROR	0x51
UFR_CAN_NOT_OPEN_READER	0x52
UFR_READER_NOT_SUPPORTED	0x53
UFR_READER_OPENING_ERROR	0x54
UFR_READER_PORT_NOT_OPENED	0x55
UFR_CANT_CLOSE_READER_PORT	0x56
UFR_FT_STATUS_ERROR_1	0xA0
UFR_FT_STATUS_ERROR_2	0xA1
UFR_FT_STATUS_ERROR_3	0xA2
UFR_FT_STATUS_ERROR_4	0xA3
UFR_FT_STATUS_ERROR_5	0xA4
UFR_FT_STATUS_ERROR_6	0xA5
UFR_FT_STATUS_ERROR_7	0xA6
UFR_FT_STATUS_ERROR_8	0xA7
UFR_FT_STATUS_ERROR_9	0xA8
UFR_WRONG_NDEF_CARD_FORMAT	0x80
UFR_NDEF_MESSAGE_NOT_FOUND	0x81
UFR_NDEF_UNSUPPORTED_CARD_TYPE	0x82
UFR_NDEF_CARD_FORMAT_ERROR	0x83
UFR_MAD_NOT_ENABLED	0x84
UFR_MAD_VERSION_NOT_SUPPORTED	0x85
UFR_NDEF_MESSAGE_NOT_COMPATIBLE	0x86
FORBIDDEN_IN_TAG_EMULATION_MODE	0x90
UFR_MFP_COMMAND_OVERFLOW	0xB0
UFR_MFP_INVALID_MAC	0xB1
UFR_MFP_INVALID_BLOCK_NR	0xB2
UFR_MFP_NOT_EXIST_BLOCK_NR	0xB3
UFR_MFP_COND_OF_USE_ERROR	0xB4
UFR_MFP_LENGTH_ERROR	0xB5
UFR_MFP_GENERAL_MANIP_ERROR	0xB6
UFR_MFP_SWITCH_TO_ISO14443_4_ERROR	0xB7
UFR_MFP_ILLEGAL_STATUS_CODE	0xB8
UFR_MFP_MULTI_BLOCKS_READ	0xB9
NT4H_COMMAND_ABORTED	0xC0
NT4H_LENGTH_ERROR	0xC1
NT4H_PARAMETER_ERROR	0xC2
NT4H_NO_SUCH_KEY	0xC3

NT4H_PERMISSION_DENIED	0xC4
NT4H_AUTHENTICATION_DELAY	0xC5
NT4H_MEMORY_ERROR	0xC6
NT4H_INTEGRITY_ERROR	0xC7
NT4H_FILE_NOT_FOUND	0xC8
NT4H_BOUNDARY_ERROR	0xC9
NT4H_INVALID_MAC	0xCA
NT4H_NO_CHANGES	0xCB
multiple units - return from the functions with ReaderList_ prefix in name	
UFR_DEVICE_WRONG_HANDLE	0x100
UFR_DEVICE_INDEX_OUT_OF_BOUND	0x101
UFR_DEVICE_ALREADY_OPENED	0x102
UFR_DEVICE_ALREADY_CLOSED	0x103
UFR_DEVICE_IS_NOT_CONNECTED	0x104
Originality check status codes:	
UFR_NOT_NXP_GENUINE	0x200
UFR_OPEN_SSL_DYNAMIC_LIB_FAILED	0x201
UFR_OPEN_SSL_DYNAMIC_LIB_NOT_FOUND	0x202
uFCoder library status codes:	
UFR_NOT_IMPLEMENTED	0x1000
UFR_COMMAND_FAILED	0x1001
UFR_TIMEOUT_ERR	0x1002
UFR_FILE_SYSTEM_ERROR	0x1003
UFR_FILE_SYSTEM_PATH_NOT_EXISTS	0x1004
UFR_FILE_NOT_EXISTS	0x1005
TLS 1.2 status codes:	
TLS_ERR_OPENING_SOCKET	0x5000
TLS_ERR_NO_SUCH_HOST	0x5001
TLS_CONNECTING_ERROR	0x5002
TLS_ERR_SERVER_UNEXPECTEDLY_CLOSED_CONNECTION	0x5003
TLS_ERR_UNKNOWN_GIDS_CERTIFICATE_FORMAT	0x5004
TLS_ERR_SET_PIN_FOR_GIDS_CERT_ONLY	0x5005
TLS_ERR_GIDS_PIN_CODE_WRONG	0x5006
TLS_ERR_UNSUPPORTED_CERTIFICATE_TYPE	0x5007
TLS_ERR_PRIVATE_KEY_CONTEXT_WRONG	0x5008
APDU status codes:	
UFR_APDU_TRANSCEIVE_ERROR	0xAE
UFR_APDU_JC_APP_NOT_SELECTED	0x6000
UFR_APDU_JC_APP_BUFF_EMPTY	0x6001
UFR_APDU_WRONG_SELECT_RESPONSE	0x6002
UFR_APDU_WRONG_KEY_TYPE	0x6003
UFR_APDU_WRONG_KEY_SIZE	0x6004
UFR_APDU_WRONG_KEY_PARAMS	0x6005
UFR_APDU_WRONG_SIGNING_ALGORITHM	0x6006
UFR_APDU_PLAIN_TEXT_MAX_SIZE_EXCEEDED	0x6007
UFR_APDU_UNSUPPORTED_KEY_SIZE	0x6008
UFR_APDU_UNSUPPORTED_ALGORITHMS	0x6009

UFR_APDU_PKI_OBJECT_NOT_FOUND	0x600A
UFR_APDU_MAX_PIN_LENGTH_EXCEEDED	0x600B
UFR_DIGEST_LENGTH_DOES_NOT_MATCH	0x600C
JCApp status codes:	
UFR_APDU_SW_TAG	0x000A0000
UFR_APDU_SW_OPERATION_IS_FAILED	0x000A6300
UFR_APDU_SW_WRONG_LENGTH	0x000A6700
UFR_APDU_SW_SECURITY_STATUS_NOT_SATISFIED	0x000A6982
UFR_APDU_SW_AUTHENTICATION_METHOD_BLOCKED	0x000A6983
UFR_APDU_SW_DATA_INVALID	0x000A6984
UFR_APDU_SW_CONDITIONS_NOT_SATISFIED	0x000A6985
UFR_APDU_SW_WRONG_DATA	0x000A6A80
UFR_APDU_SW_FILE_NOT_FOUND	0x000A6A82
UFR_APDU_SW_RECORD_NOT_FOUND	0x000A6A83
UFR_APDU_SW_DATA_NOT_FOUND	0x000A6A88
UFR_APDU_SW_ENTITY_ALREADY_EXISTS	0x000A6A89
UFR_APDU_SW_INS_NOT_SUPPORTED	0x000A6D00
UFR_APDU_SW_NO_PRECISE_DIAGNOSTIC	0x000A6F00
Cryptographic subsystem status codes:	
CRYPTO_SUBSYS_NOT_INITIALIZED	0x6101
CRYPTO_SUBSYS_SIGNATURE_VERIFICATION_ERROR	0x6102
CRYPTO_SUBSYS_MAX_HASH_INPUT_EXCEEDED	0x6103
CRYPTO_SUBSYS_INVALID_HASH_ALGORITHM	0x6104
CRYPTO_SUBSYS_INVALID_CIPHER_ALGORITHM	0x6105
CRYPTO_SUBSYS_INVALID_PADDING_ALGORITHM	0x6106
CRYPTO_SUBSYS_WRONG_SIGNATURE	0x6107
CRYPTO_SUBSYS_WRONG_HASH_OUTPUT_LENGTH	0x6108
CRYPTO_SUBSYS_UNKNOWN_ECC_CURVE	0x6109
CRYPTO_SUBSYS_HASHING_ERROR	0x610A
CRYPTO_SUBSYS_INVALID_SIGNATURE_PARAMS	0x610B
CRYPTO_SUBSYS_INVALID_RSA_PUB_KEY	0x610C
CRYPTO_SUBSYS_INVALID_ECC_PUB_KEY_PARAMS	0x610D
CRYPTO_SUBSYS_INVALID_ECC_PUB_KEY	0x610E
UFR_WRONG_PEM_CERT_FORMAT	0x61C0
X.509 status codes:	
X509_CAN_NOT_OPEN_FILE	0x6200
X509_WRONG_DATA	0x6201
X509_WRONG_LENGTH	0x6202
X509_UNSUPPORTED_PUBLIC_KEY_TYPE	0x6203
X509_UNSUPPORTED_PUBLIC_KEY_SIZE	0x6204
X509_UNSUPPORTED_PUBLIC_KEY_EXPONENT	0x6205
X509_EXTENSION_NOT_FOUND	0x6206
X509_WRONG_SIGNATURE	0x6207
X509_UNKNOWN_PUBLIC_KEY_TYPE	0x6208
X509_WRONG_RSA_PUBLIC_KEY_FORMAT	0x6209
X509_WRONG_ECC_PUBLIC_KEY_FORMAT	0x620A
X509_SIGNATURE_NOT_MATCH_CA_PUBLIC_KEY	0x620B

X509_UNSUPPORTED_SIGNATURE_SCH	0x620C
X509_UNSUPPORTED_ECC_CURVE	0x620D
PKCS#7 status codes:	
PKCS7_WRONG_DATA	0x6241
PKCS7_UNSUPPORTED_SIGNATURE_SCHEME	0x6242
PKCS7_SIG_SCH_NOT_MATCH_CERT_KEY_TYPE	0x6243
PKCS7_WRONG_SIGNATURE	0x6247
MRTD status codes:	
MRTD_SECURE_CHANNEL_SESSION_FAILED	0x6280
MRTD_WRONG_SOD_DATA	0x6281
MRTD_WRONG_SOD_LENGTH	0x6282
MRTD_UNKNOWN_DIGEST_ALGORITHM	0x6283
MRTD_WARNING_DOES_NOT_CONTAINS_DS_CERT	0x6284
MRTD_DATA_GROUOP_INDEX_NOT_EXIST	0x6285
MRTD_EF_COM_WRONG_DATA	0x6286
MRTD_EF_DG_WRONG_DATA	0x6287
MRTD_EF_DG1_WRONG_LDS_VERSION_LENGTH	0x6288
MRTD_VERIFY_CSCA_NOT_EXIST	0x6289
MRTD_VERIFY_WRONG_DS_SIGNATURE	0x628A
MRTD_VERIFY_WRONG_CSCA_SIGNATURE	0x628B
MRTD_MRZ_CHECK_ERROR	0x628C
EMV status error codes	
SYS_ERR_OUT_OF_MEMORY	0x7001
EMV_ERR_WRONG_INPUT_DATA	0x7002
EMV_ERR_MAX_TAG_LEN_BYTES_EXCEEDED	0x7004
EMV_ERR_TAG_NOT_FOUND	0x7005
EMV_ERR_TAG_WRONG_SIZE	0x7006
EMV_ERR_TAG_WRONG_TYPE	0x7007
EMV_ERR_IN_CARD_READER	0x7008
EMV_ERR_READING_RECORD	0x7009
EMV_ERR_PDOL_IS_EMPTY	0x7010
EMV_ERR_LIST_FORMAT_NOT_FOUND	0x7011
EMV_ERR_AFL_NOT_FOUND	0x7012
EMV_ERR_AID_NOT_FOUND	0x7013
ICAO Master List status codes:	
ICAO_ML_WRONG_FORMAT	0x6300
ICAO_ML_CAN_NOT_OPEN_FILE	0x6301
ICAO_ML_CAN_NOT_READ_FILE	0x6302
ICAO_ML_CERTIFICATE_NOT_FOUND	0x6303
ICAO_ML_WRONG_SIGNATURE	0x6307

DESFIRE Card Status Codes:

READER_ERROR	2999
NO_CARD_DETECTED	3000
CARD_OPERATION_OK	3001

WRONG_KEY_TYPE	3002
KEY_AUTH_ERROR	3003
CARD_CRYPTO_ERROR	3004
READER_CARD_COMM_ERROR	3005
PC_READER_COMM_ERROR	3006
COMMIT_TRANSACTION_NO_REPLY	3007
COMMIT_TRANSACTION_ERROR	3008
DESFIRE_CARD_NO_CHANGES	0x0C0C
DESFIRE_CARD_OUT_OF_EEPROM_ERROR	0x0C0E
DESFIRE_CARD_ILLEGAL_COMMAND_CODE	0x0C1C
DESFIRE_CARD_INTEGRITY_ERROR	0x0C1E
DESFIRE_CARD_NO_SUCH_KEY	0x0C40
DESFIRE_CARD_LENGTH_ERROR	0x0C7E
DESFIRE_CARD_PERMISSION_DENIED	0x0C9D
DESFIRE_CARD_PARAMETER_ERROR	0x0C9E
DESFIRE_CARD_APPLICATION_NOT_FOUND	0x0CA0
DESFIRE_CARD_APPL_INTEGRITY_ERROR	0x0CA1
DESFIRE_CARD_AUTHENTICATION_ERROR	0x0CAE
DESFIRE_CARD_ADDITIONAL_FRAME	0x0CAF
DESFIRE_CARD_BOUNDARY_ERROR	0x0CBE
DESFIRE_CARD_PICC_INTEGRITY_ERROR	0x0CC1
DESFIRE_CARD_COMMAND_ABORTED	0x0CCA
DESFIRE_CARD_PICC_DISABLED_ERROR	0x0CCD
DESFIRE_CARD_COUNT_ERROR	0x0CCE
DESFIRE_CARD_DUPLICATE_ERROR	0x0CDE
DESFIRE_CARD_EEPROM_ERROR_DES	0x0CEE

DESFIRE_CARD_FILE_NOT_FOUND	0x0CF0
DESFIRE_CARD_FILE_INTEGRITY_ERROR	0x0CF1

Appendix: DLogic CardType enumeration

TAG_UNKNOWN	0x00
DL_MIFARE_ULTRALIGHT	0x01
DL_MIFARE_ULTRALIGHT_EV1_11	0x02
DL_MIFARE_ULTRALIGHT_EV1_21	0x03
DL_MIFARE_ULTRALIGHT_C	0x04
DL_NTAG_203	0x05
DL_NTAG_210	0x06
DL_NTAG_212	0x07
DL_NTAG_213	0x08
DL_NTAG_215	0x09
DL_NTAG_216	0x0A
DL_MIKRON_MIK640D	0x0B
NFC_T2T_GENERIC	0x0C
DL_NT3H_1101	0x0D
DL_NT3H_1201	0x0E
DL_NT3H_2111	0x0F
DL_NT3H_2211	0x10
DL_NTAG_413_DNA	0x11
DL_NTAG_424_DNA	0x12
DL_NTAG_424_DNA_TT	0x13
DL_NTAG_210U	0x14
DL_NTAG_213_TT	0x15
DL_MIFARE_MINI	0x20
DL_MIFARE_CLASSIC_1K	0x21
DL_MIFARE_CLASSIC_4K	0x22
DL_MIFARE_PLUS_S_2K	0x23
DL_MIFARE_PLUS_S_4K	0x24
DL_MIFARE_PLUS_X_2K	0x25
DL_MIFARE_PLUS_X_4K	0x26
DL_MIFARE_PLUS_S_2K_SL0	0x23
DL_MIFARE_PLUS_S_4K_SL0	0x24
DL_MIFARE_PLUS_X_2K_SL0	0x25
DL_MIFARE_PLUS_X_4K_SL0	0x26
DL_MIFARE_DESFIRE	0x27
DL_MIFARE_DESFIRE_EV1_2K	0x28
DL_MIFARE_DESFIRE_EV1_4K	0x29
DL_MIFARE_DESFIRE_EV1_8K	0x2A
DL_MIFARE_DESFIRE_EV2_2K	0x2B
DL_MIFARE_DESFIRE_EV2_4K	0x2C
DL_MIFARE_DESFIRE_EV2_8K	0x2D

DL_MIFARE_PLUS_S_2K_SL1	0x2E
DL_MIFARE_PLUS_X_2K_SL1	0x2F
DL_MIFARE_PLUS_EV1_2K_SL1	0x30
DL_MIFARE_PLUS_X_2K_SL2	0x31
DL_MIFARE_PLUS_S_2K_SL3	0x32
DL_MIFARE_PLUS_X_2K_SL3	0x33
DL_MIFARE_PLUS_EV1_2K_SL3	0x34
DL_MIFARE_PLUS_S_4K_SL1	0x35
DL_MIFARE_PLUS_X_4K_SL1	0x36
DL_MIFARE_PLUS_EV1_4K_SL1	0x37
DL_MIFARE_PLUS_X_4K_SL2	0x38
DL_MIFARE_PLUS_S_4K_SL3	0x39
DL_MIFARE_PLUS_X_4K_SL3	0x3A
DL_MIFARE_PLUS_EV1_4K_SL3	0x3B
DL_MIFARE_PLUS_SE_SL0	0x3C
DL_MIFARE_PLUS_SE_SL1	0x3D
DL_MIFARE_PLUS_SE_SL2	0x3E
DL_MIFARE_DESFIRE_LIGHT	0x3F
DL_GENERIC_ISO14443_4	0x40
DL_GENERIC_ISO14443_TYPE_B	0x41
DL_GENERIC_ISO14443_4_TYPE_B	0x41
DL_GENERIC_ISO14443_3_TYPE_B	0x42
DL_IMEI_UID	0x80

Appendix: DLogic reader type enumeration

Value	Reader name
0xD1150021	µFR Classic
0xD2150021	µFR Advance
0xD3150021	µFR PRO
0xD1180022	µFR Nano Classic
0xD3180022	µFR Nano PRO
0xD1190222	µFR Nano Classic RS232
0xD3190222	µFR Nano PRO RS232
0xD11A0022	µFR Classic Card Size
0xD21A0022	µFR Advance Card Size

0xD31A0022	µFR PRO Card Size
0xD11A0222	µFR Classic Card Size RS232
0xD21A0222	µFR Advance Card Size RS232
0xD31A0222	µFR PRO Card Size RS232
0xD11B0022	µFR Classic Card Size RF-AMP
0xD21B0022	µFR Advance Card Size RF-AMP
0xD31B0022	µFR PRO Card Size RF-AMP
0xD11B0222	µFR Classic Card Size RS232 RF-AMP
0xD21B0222	µFR Advance Card Size RS232 RF-AMP
0xD31B0222	µFR PRO Card Size RS232 RF-AMP
0xD1380022	uFR Nano Plus
0xD3380022	uFR Nano PRO Plus
0xD1390022	uFR Nano RS232 Plus
0xD23A0022	uFR Classic Card Size Plus
0xD33A0022	uFR Classic Card Size PRO Plus
0xD23A0222	uFR Classic Card Size RS232 Plus
0xD23B0022	uFR Classic Card Size Plus with RF Booster
0xD33B0022	uFR Classic Card Size PRO Plus with RF Booster
0xD33B0222	uFR Classic Card Size RS232 Plus with RF Booster
0xD13A0022	uFR XL
0xD13A0222	uFR XL RS232
0xD13B0022	uFR XL with RF Booster
0xD13B0222	uFR XL RS232 with RF Booster

Appendix: FTDI troubleshooting

On Windows systems, it is pretty straightforward with .msi installer executable.

On Linux platforms, few more things must be provided:

- Appropriate user permissions on FTDI and uFCoder libraries
- "`ftdi_sio`" and helper module "`usbserial`" must be removed/unloaded for proper functioning. Each time device is plugged in, Linux kernel loads appropriate module. So, each time device is plugged, you must issue following command in CLI: `sudo rmmod ftdi_sio usbserial`
- This can be painful, so good practice is to blacklist these two modules in "`etc/modprobe.d/`" directory. Create new file called "`ftdi.conf`" and add following line :

```
#disable auto load FTDI modules - D-LOGIC
blacklist ftdi_sio
blacklist usbserial
```

On macOS, it is good enough to follow FTDI's guidelines for proper driver installation.

Update: since Mac OS version 10.11 El Capitan, macOS introduces SIP (System Integration Protection) which does not allow user to write into system directories like 'usr/lib' and similar, which makes a lot of problems in implementation. For that purpose, 'libuFCoder.dylib' library embeds FTDI's library too, so there is no need for installation of FTDI's drivers.

Previous macOS versions works fine with FTDI's D2XX drivers.

D2XX drivers links: http://www.ftdichip.com/Drivers/D2XX.htm

Direct link to current drivers: http://www.ftdichip.com/Drivers/D2XX/MacOSX/D2XX1.2.2.dmg

Install instructions are located in the archive. You need to install/copy needed drivers.

Other kernel extensions problems:

To successfully open the FTDI port, it is necessary to check if another FTDI module (kernel extension) is loaded, and if it is, it needs to be deactivated.

Procedure:

1. plug-in FTDI device (uFReader) and wait a few seconds
2. open console
3. you can check if device is detected:

```
$ sudo dmesg
FTDIUSBSerialDriver:          0   **4036001** start - ok
```

4. check if kernel extension is loaded for FTDI:

```
$ kextstat | grep -i ftdi
```

```
      94   0 0xffffff7f82041000 0x8000    0x8000
**com.FTDI.driver.FTDIUSBSerialDriver** (2.2.18) <70 34 5 4 3  1>
```

5. you need to deactivate it - eject it from memory

```
sudo kextunload /System/Library/Extensions/FTDIUSBSerialDriver.kext
```

Remark - with the system OS X 10.11 (El Capitan)

After the module is removed, it returns again. It is necessary to download the Helper from FTDI site and to run it on the machine, and after that restart is required.

Information from site:

If using a device with standard FTDI vendor and product identifiers, install D2xxHelper to prevent OS X 10.11 (El Capitan) claiming the device as a serial port (locking out D2XX programs).

This is how to load driver on El Capitan:

```
$ kextstat | grep -i ftd  146 0 0xffffff7f82d99000 0x7000   0x7000
com.apple.driver.AppleUSBFTDI (5.0.0) D853EEF2-435D-370E-AFE3-DE49CA29DF47 <123 38 5 4
3 1>
$ sudo kextunload /System/Library/Extensions/AppleUSBFTDI.kext
```

After this, FTDI devices are ready to work with FTD2XX libraries.

From library version 5.0.28. Mac OS support

Mac OS 10.14 (Mojave).

USB serial works if the device opened with ReaderOpenEx with virtual com port option without unload /System/Library/Extension/AppleUSBFTDI.kext . Com port name is /dev/tty.usbserial-xxxxxxxx.

Mac OS 10.15 (Catalina).

USB serial and FTD2xx works without unloading /System/Library/DriverExtenstons/DriverKit.AppleUSBFTDI.dext.

Appendix: Change log

Firmware version 5.0.1 and later apply only to uFR PLUS devices

Date	Description	API revision	refers to the lib version / firmware ver.
2022-03-24	RGB and RF period definition	2.42	5.0.66/5.063

2022-03-11	RGB signalization in the sleep mode.	2.41	5.0.64/5.0.62
2022-02-23	T2T NFC counter in the card emulation mode	2.40	5.0.60/5.0.61
2022-01-19	NTAG 213 TT support.	2.39	5.0.59/5.0.60
2021-12-28	Fully Extended APDU support implemented from uFCoder library version 5.0.57 and uFR Plus firmware version 5.0.57. *Some typographical errors in the document have been corrected.*	2.38	5.0.57/5.0.57
2021-11-22	TLS 1.2 with TLS/SSL Client Certificate Authentication using Generic Identity Device Specification (GIDS) smart card support. Added TLS 1.2 and GIDS status codes.	2.37	5.0.57/5.0.22
2021-10-30	NDEF functions updated. "_Bluetooth" suffixes renamed to "_BT"	2.36	5.0.56 /
2021-10-06	Card size and XL reader RGB diodes on PCB signalization	2.35	5.0.55/5.0.55
2021-09-08	uFR XL add into Dlogic reader type	2.34	
2021-02-12	Added EspGetReaderSerialNumber	2.33	5.0.50/ uFR Online: 2.4.6
2021-01-11	RF field switch on or off in the multi card mode	2.32	5.0.48/5.0.51
2020-10-16	Desfire EV2 and Desfire Light originality checking.	2.31	5.0.45/5.0.44
2020-10-08	NTAG 424 DNA TT support. NT4H originality checking.	2.30	5.0.43 / 5.0.43
2020-09-03	EMV functions, definitions and prototypes. Updated uFCoder library error codes.	2.29	5.0.41 / 5.0.1
2020-04-09	Transaction MAC support. Desfire Light and Desfire EV2	2.28	5.0.37 / 5.0.38
2020-03-13	Desfire delete application with application master key	2.27	5.0.36 / 5.0.37
2020-02-27	Mifare Plus X, SE or EV1 value block operations	2.26	5.0.34 / 5.0.36
2020-02-18	New function explained: SetISO14443_4_Mode_GetATS() Used to get the tag ATS acquired in the selection process.	2.25	5.0.32 / 5.0.34
2020-02-13	NTAG emulation into RAM (1024 bytes 256 pages) GetReaderStatus	2.24	5.0.31 / 5.0.33
2020-01-31	NT4H (NTAG 4xx DNA) support.	2.23	5.0.29 / 5.0.32

	Desfire light support. DesfireClearRecorFile functions bug fix.		
2020-01-23	Custom baud rate support. Mac OS USB serial support.	2.22	5.0.28 / 5.0.31
2020-01-10	Added description of a new helper function for Machine Readable Travel Documents (MRTD) support, MRTD_MRZSubjacentCheck(). Added new status code: MRTD_MRZ_CHECK_ERROR.	2.21	5.0.26 / 5.0.22
2019-12-17	Added general purpose cryptographic functions for hashing and digital signature verification. Updated Machine Readable Travel Documents (MRTD) support. Updated status codes (X.509, PKCS#7, MRTD and ICAO ML status codes). Updated Tag Emulation mode and WriteEmulationNDEF description (maximum NDEF size for emulation).	2.20	5.0.25 / 5.0.22
2019-12-09	Added EspSetTransparentReader function for uFR Online.	2.19	5.0.24 / uFR Online: 2.2.1
2019-11-14	Added ReaderOpen_uFROnline function which opens communication with uFR Online devices by serial number. ReaderOpen and ReaderOpenEx functions are also extended.	2.18	5.0.23 / uFR Online: 2.1.6W
2019-10-29	Using Mifare Classic functions for Mifare Plus card in SL3 with AES key which calculated from Crypto1 key	2.17	5.0.19/5.0.29
2019-09-26	SAM support	2.16	5.0. 16/5.100.27
2019-08-28	Machine Readable Travel Documents (MRTD) support	2.15	5.0.12/5.0.22
2019-08-09	Desfire records support	2.14	5.0.14/5.0.25
2019-08-06	Desfire DES, 2K3DES, and 3K3DES keys support	2.13	5.0.14/5.0.25
2019-07-18	ESP IO control added. Android support.	2.11	
2019-05-21	DLStorage JCApp support	2.10	5.0.8 / 5.0.20
2019-05-21	In the JCAppSelectByAid() function description added guidelines for the DLStorage JCApp selection procedure.	2.10	5.0.8 / 5.0.20
2019-05-21	DLSigner JCApp AID has been changed to a valid one 'F0 44 4C 6F 67 69 63 01 01' in the whole document.	2.10	5.0.1 / 5.0.7
2019-05-21	Updated uFCoder library error codes, APDU Error	2.10	5.0.1 / 5.0.1

	Codes and JCApp error codes.		
2019-05-21	Common JCApp PIN functions explained	2.10	5.0.1 / 5.0.1
2019-05-21	Java Card Application (JCApp) explained	2.10	5.0.1 / 5.0.1
2019-05-16	Desfire get Application IDs added	2.9	5.0.7 / 5.0.19
2018-12-14	UfrRgbLightControl for classic devices only	2.8	4.4.6 / 5.0.11
2018-11-20	Additional settings in ReaderOpenEx() Supported communication via TCP/IP	2.7	4.4.2 / 5.0.1
2018-11-05	Supported communication via UDP	2.6	4.4.1 / 5.0.1
2018-10-01	Anti-collision support (multi card reader mode) added	2.5	4.3.13 / 5.0.1
2018-09-05	Functions for Mifare Ultralight C card for uFR PLUS devices only	2.4	4.3.13 / 5.0.1
2018-07-02	APDU functions for switching between ISO14443-4 and ISO7816 for uFR PLUS devices with SAM option only	2.3	
2018-06-18	Support for ISO7816 protocol for uFR PLUS devices with SAM option only	2.2	
2018-06-18	Functions for Mifare Plus card (AES encryption in reader) for uFR PLUS devices only	2.2	
2018-05-29	PKI infrastructure and digital signature support	2.1	4.3.8 / 3.9.55