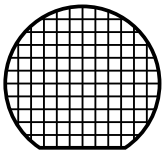
SRTAG2KL

NFC Forum Type 4 Tag IC with 2-Kbit EEPROM

Datasheet - preliminary data



Wafer (SB12I)

Description

The SRTAG2KL device is a NFC tag IC.

It embeds an EEPROM memory. It can be operated from a 13.56 MHz RFID reader or an NFC phone.

The SRTAG2KL is an NFC Forum Type 4 Tag; it communicates using the ISO/IEC 14443 Type A protocol.

Features

Contactless interface

- NFC Forum Type 4 Tag
- ISO/IEC 14443 Type A
- 106 Kbps data rate
- Internal tuning capacitance: 50 pF

Memory

- 256-byte (2-kbit) EEPROM
- Support of NDEF data structure
- Data retention: 200 years
- Endurance: 1 million erase-write cycles
- Read up to 255 bytes in a single command
- Write up to 54 bytes in a single command
- Chaining capability
- 7 bytes unique identifier (UID)
- 128 bits passwords protection
- 20 bits event counter with anti-tearing

This is preliminary information on a new product now in development or undergoing evaluation. Details are subject to change without notice.

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Contents

1 Functional description 8

1.1 Functional mode 9

1.1.1 Tag mode 9

2 Signal descriptions 10

2.1 Antenna coil (AC0, AC1) 10

3 SRTAG2KL memory management 11

3.1 Memory structure 11

3.1.1 File identifier 11

3.1.2 CC file layout 11

3.1.3 NDEF file layout 12

3.1.4 System file layout 13

3.2 Read and write access rights to the NDEF File 13

3.2.1 State of the Read and Write access rights 14

3.2.2 Changing the read access right to NDEF files 14

3.2.3 Changing the write access right to NDEF files 15

3.3 Access right life time 16

3.4 NDEF file passwords 16

3.5 Read/Write counter 16

4 Communication mechanism 18

4.1 Master and slave 18

5 RF command sets 19

5.1 Structure of the command sets 20

5.2 I-Block format 20

5.2.1 C-APDU: payload format of a command 22

5.2.2 R-APDU: payload format of a response 22

5.3 R-Block format 22

5.4 S-Block format 24

5.5 CRC of the RF frame 25

5.6 NFC Forum Type 4 Tag protocol 25

5.6.1 Commands set . . . 25
5.6.2 Status and error codes . . . 26
5.6.3 NDEF Tag Application Select command . . . 27
5.6.4 Capability Container Select command . . . 27
5.6.5 NDEF Select command . . . 28
5.6.6 System File Select command . . . 29
5.6.7 ReadBinary command . . . 30
5.6.8 UpdateBinary command . . . 31
5.7 ISO/IEC 7816-4 commands . . . 32
5.7.1 Verify command . . . 32
5.7.2 Change Reference Data command . . . 33
5.7.3 Enable Verification Requirement command . . . 34
5.7.4 Disable Verification Requirement command . . . 35
5.8 ST Proprietary command set . . . 36
5.8.1 ExtendedReadBinary command . . . 36
5.8.2 EnablePermanentState command . . . 37
5.9 Specific RF command set . . . 38
5.9.1 Anticollision command set . . . 38
5.9.2 RATS command and ATS response . . . 39
5.9.3 PPS command & response . . . 41

6 RF device operation . . . 43
6.1 Anticollision and Device Activation command set for the RF interface . . . 43
6.2 Open an RFsession . . . 43
6.3 Close an RFsession . . . 43
6.4 Applicative command set . . . 43

7 Functional procedures . . . 44
7.1 Selection of an NDEF message . . . 44
7.2 Reading of an NDEF message . . . 44
7.3 Reading a locked NDEF file . . . 44
7.4 Locking an NDEF file . . . 44
7.5 Unlocking an NDEF file . . . 45
7.6 Reaching the read-only state for an NDEF file . . . 45
7.7 Changing a File type Procedure . . . 45

8 UID: Unique identifier 46

9 Maximum rating 47

10 RF electrical parameters 48

11 Part numbering 49

12 Revision history 50

List of tables

Table 1. Signal names . . . 9
Table 2. Functional mode . . . 9
Table 3. File identifier . . . 11
Table 4. CC file layout for 1 NDEF file . . . 11
Table 5. NDEF file layout . . . 12
Table 6. Field list . . . 13
Table 7. Details about the Counter config field . . . 13
Table 8. Read access right . . . 14
Table 9. Write access right . . . 14
Table 10. RF command sets . . . 19
Table 11. I-Block format . . . 20
Table 12. PCB field of the I-Block format . . . 21
Table 13. C-APDU format . . . 22
Table 14. R-APDU format . . . 22
Table 15. R-Block format . . . 23
Table 16. R-Block detailed format . . . 24
Table 17. S-Block format . . . 24
Table 18. S-Block detailed format . . . 25
Table 19. Command set overview . . . 25
Table 20. Status code of the SRTAG2KL . . . 26
Table 21. Error code of the SRTAG2KL . . . 26
Table 22. C-APDU of the NDEF Tag Application Select command . . . 27
Table 23. R-APDU of the NDEF Tag Application Select command . . . 27
Table 24. C-APDU of the Capability Container Select command . . . 28
Table 25. R-APDU of the Capability Container Select command . . . 28
Table 26. C-APDU of the NDEF Select command . . . 28
Table 27. R-APDU of the NDEF Select command . . . 29
Table 28. C-APDU of the System File Select command . . . 29
Table 29. R-APDU of the System File Select command . . . 29
Table 30. C-APDU of the ReadBinary command . . . 30
Table 31. R-APDU of the ReadBinary command . . . 30
Table 32. C-APDU of the UpdateBinary command . . . 31
Table 33. R-APDU of the UpdateBinary command . . . 31
Table 34. Verify command format . . . 32
Table 35. R-APDU of the Verify command . . . 33
Table 36. Change reference data command format . . . 33
Table 37. R-APDU of the Change Reference Data command . . . 34
Table 38. Enable Verification Requirement command format . . . 34
Table 39. R-APDU of the Enable Verification Requirement command . . . 35
Table 40. Disable Verification Requirement command format . . . 35
Table 41. R-APDU of the Disable Verification Requirement command . . . 36
Table 42. C-APDU of the ExtendedReadBinary command . . . 36
Table 43. R-APDU of the ExtendedReadBinary command . . . 37
Table 44. EnablePermanentState command format . . . 37
Table 45. R-APDU table of the EnablePermanentState command . . . 37
Table 46. Commands issues by the RF host . . . 38
Table 47. Example of anticollision sequence . . . 38
Table 48. RATS command . . . 40

Table 49. Conversion from FDSI to FSD . . . 40
Table 50. ATS response . . . 40
Table 51. PPS command . . . 41
Table 52. Ascending and descending data rate coding . . . 41
Table 53. PPS response . . . 42
Table 54. UID format . . . 46
Table 55. Absolute maximum ratings . . . 47
Table 56. Default operating conditions . . . 48
Table 57. RF characteristics . . . 48
Table 58. Ordering information scheme for packaged devices . . . 49
Table 59. Document revision history . . . 50

List of figures

Figure 1. SRTAG2KL block diagram 8
Figure 2. Changing the read access right to an NDEF file. 15
Figure 3. Changing the write access right to an NDEF file 15

1 Functional description

The SRTAG2KL device is a NFC tag that can be accessed from the RF interface. The RF interface is based on the ISO/IEC 14443 Type A standard. The SRTAG2KL is compatible with the NFC Forum Type 4 Tag specifications and supports all corresponding commands.

Figure 1 displays the block diagram of the SRTAG2KL device.

Figure 1. SRTAG2KL block diagram

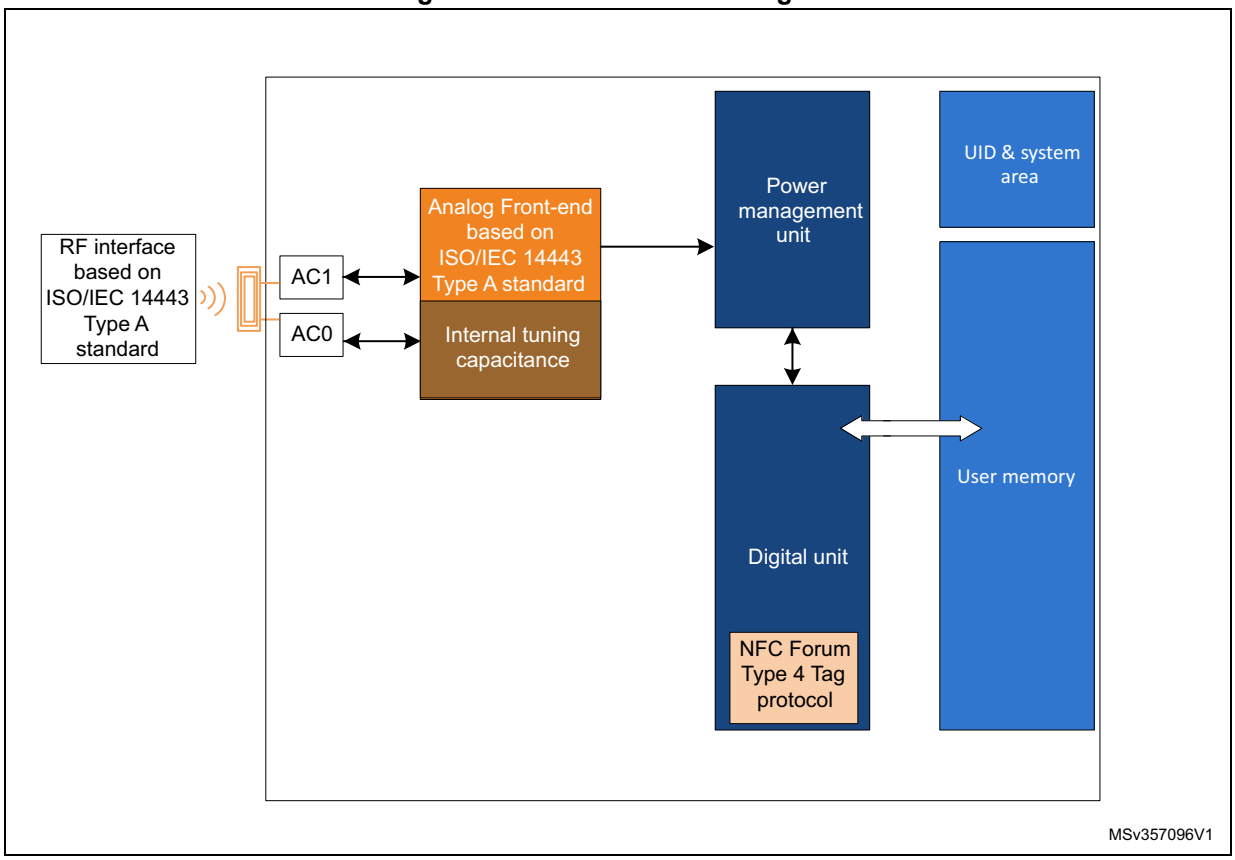


Table 1. Signal names

Signal name	Function	Direction
AC0, AC1	Antenna coils	-

1.1 Functional mode

The SRTAG2KL has just one functional mode available (see *Table 2*).

Table 2. Functional mode

Mode	Supply source	Comments
Tag mode	RF field only	The RF interface operate only when RF field level is sufficient.

1.1.1 Tag mode

The SRTAG2KL is supplied by the RF field and can communicate with an RF host (RFID reader or an NFC phone). The User memory can be accessed by the RF commands.

2 Signal descriptions

2.1 Antenna coil (AC0, AC1)

These inputs are used to connect the device to an external coil exclusively. It is advised not to connect any other DC or AC path to AC0 or AC1.

When correctly tuned, the coil is used to access the device using NFC Forum Type 4 commands.

3 SRTAG2KL memory management

3.1 Memory structure

The SRTAG2KL supports the NDEF Tag Application as defined in the NFC Forum Type 4 Tag. The SRTAG2KL is composed of three files:

- One Capability Container file
- One NDEF file
- One System file: this file is an ST-proprietary file

The System file contains some information on the configuration of the SRTAG2KL device. The CC file gives some information about the SRTAG2KL itself and the NDEF file. The NDEF file contains the User data.

3.1.1 File identifier

The file identifier is the value used in the Select command to select a file.

Table 3. File identifier

File identifier	Meaning
0xE101	System file
0xE103	CC file
0x0001	NDEF file

3.1.2 CC file layout

The CC file gives some information about the SRTAG2KL and the NDEF file. This file is a read-only file for the RF host and cannot be modified by issuing a write command.

The T field, Read Access and Write Access fields can be changed by the RF host by issuing a specific process (refer to *Section 7: Functional procedures*).

Table 4. CC file layout for 1 NDEF file

File offset	Meaning	Value	Comments
0x0000	Length CC file	0x000F	15 bytes
0x0002	Mapping version(1)	0x20 or 0x10	V 2.0 or V 1.0
0x0003	Maximum number of bytes that can be read	0x00FF	255 bytes
0x0005	Maximum number of bytes that can be written	0x0036	54 bytes

Table 4. CC file layout for 1 NDEF file (continued)

File offset	Meaning	Value	Comments
0x0007	NDEF file control TLV	0x04 (2)	T field
0x0008		0x06	L field
0x0009		0x0001	FileID
0x000B		0x0100	Maximum NDEF file size in Byte
0x000D		0x00 (2)	Read access
0x000E		0x00 (2)	Write access

1. According to the reader command format SRTAG2KL will automatically align to the corresponding NFC Forum version.
2. Delivery state.

3.1.3 NDEF file layout

The NDEF file contains the NDEF message which contains the User data. The RF host can read and write data inside the file. The first two bytes named NDEF Message Length define the size of the NDEF message. The NDEF Message Length shall be managed by the application and the SRTAG2KL device does not check if its value is relevant vs the data written by the RF host. The SRTAG2KL device uses the NDEF Message Length, e. g. the standard read can be processed only inside the NDEF message; otherwise, the SRTAG2KL device returns an error code. For more details about the read command, refer to *Section 5.6.7: ReadBinary command*.

Table 5. NDEF file layout

File offset	Byte 0	Byte 1	Byte 2	Byte 3
0x0000	NDEF message length		User data	User data
0x0004	User data	User data	User data	User data
...	...	...	...	...
...	...	...	...	...
...	...	...	...	...
0x00FC	...	...	...	User data

3.1.4 System file layout

The system file specifies the configuration of the SRTAG2KL. *Table 6* lists the different fields.

Table 6. Field list

File offset	Field name	Number of bytes	Read access	Write access	Delivery state
0x0000	Length system file	2	yes	-	0x0012
0x0002	ST Reserved	1	yes	none	0x80
0x0003	Event Counter Config	1	yes	yes (1)	0x00
0x0004	20 bits counter (MS nibble 0x0)	3	yes	none	0x000000
0x0007	Product version	1	yes	none	0x11(2)
0x0008	UID	7	yes	none	0x02E2 xx xx xx xx xx (3)
0x000F	Memory Size - 1	2	yes	none	0x00FF
0x0011	Product Code	1	yes	none	0xE2

1. Configuration bytes can be locked by setting the Most significant bit to 1. Once locked, these bytes cannot be changed anymore.
2. ST reserved.
3. x values are defined by ST to ensure UID unicity.

Table 7. Details about the Counter config field

File offset	b7	b6-b2	b1	b0
0x0003				
Counter config lock bit: 0b0: unlocked 0b1: locked				
0b00000: ST reserved				
Counter enable: 0b0: disable 0b1: enable				
Counter increment: 0b0: on Read 0b1: on Write				

3.2 Read and write access rights to the NDEF File

The NDEF file can be locked for read or write accesses. It is also protected by a 128-bit password that the host shall present before accessing the NDEF file. There are two 128-bit passwords, one for the read access and the other one for the write access.

An NDEF file can be permanently locked for read or write accesses. Thus, the host cannot access the NDEF file.

The read password shall be sent to the SRTAG2KL device before reading a read-locked NDEF file.

The write password shall be present on the SRTAG2KL device before writing a write-locked NDEF file. The write password shall be sent to change the read or write access. The read or write access right is defined for the NDEF file.

3.2.1 State of the Read and Write access rights

Two bytes in the CC file are used to define the Read and Write access rights to the NDEF file. For more details, refer to *Section 3.1.2: CC file layout*.

Table 8. Read access right

Value	Meaning
0x00	Read access without any security
0x80	Locked (1)
0xFE	Read not authorized

1. The read password shall be sent before reading in the NDEF file.

Table 9. Write access right

Value	Meaning
0x00	Write access without any security
0x80	Locked (1)
0xFF	Write not authorized

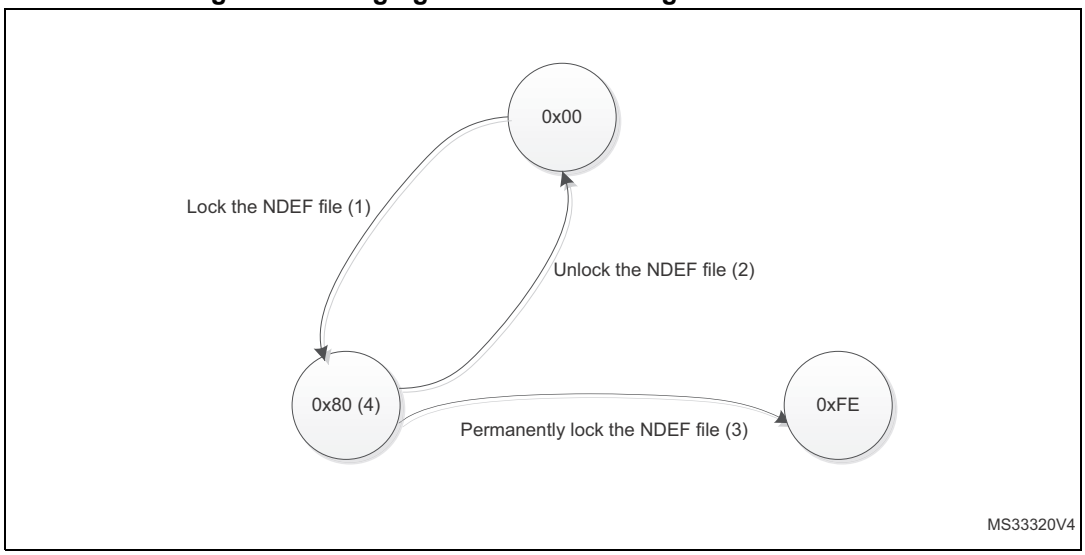
1. The write password shall be sent before writing in the NDEF file.

The state 0xFF and 0xFE cannot be changed by using the Read or Write passwords.

3.2.2 Changing the read access right to NDEF files

The state diagram on *Figure 2* shows how to change the access right to read an NDEF file.

Figure 2. Changing the read access right to an NDEF file

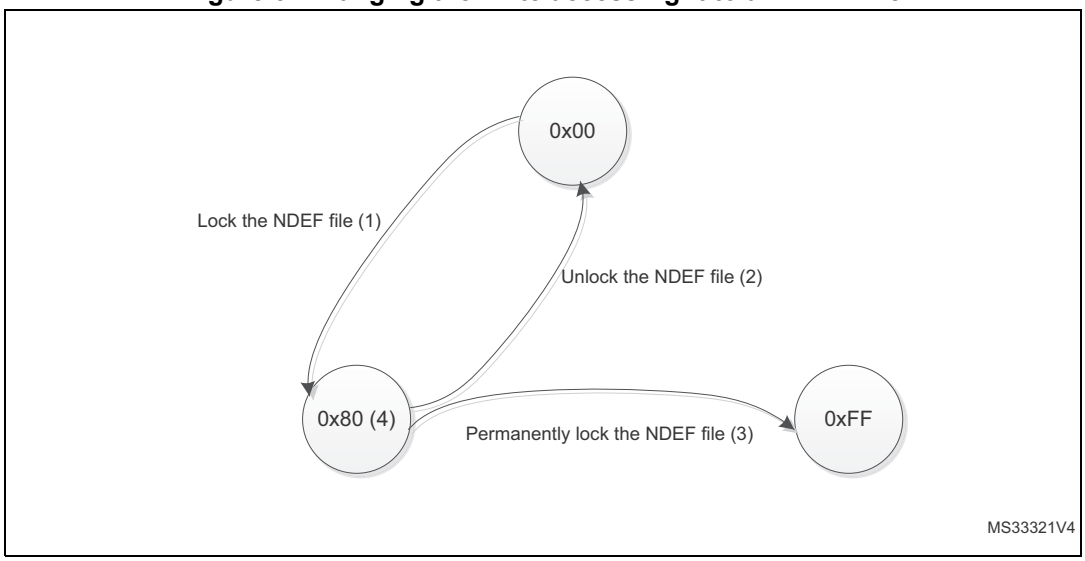


1. See the procedure to lock the read access (*Section 7.4: Locking an NDEF file*).
2. See the procedure to unlock the read access (*Section 7.5: Unlocking an NDEF file*).
3. See the procedure to permanently lock the read access (*Section 7.6: Reaching the read-only state for an NDEF file*).
4. Proprietary state, not defined by NFC Forum Type 4 Tag.

3.2.3 Changing the write access right to NDEF files

The state diagram on *Figure 3* shows how to change the write access right to an NDEF file.

Figure 3. Changing the write access right to an NDEF file



1. See the procedure to lock the write access.
2. See the procedure to unlock the write access.
3. See the procedure to permanently lock the write access (*Section 7.6: Reaching the read-only state for an NDEF file*).
4. Proprietary state, not defined by NFC Forum Type 4 Tag.

3.3 Access right life time

The access right life time is validated while the NDEF file is selected or until the end of the RF session. Once the read or write access right is granted, the host can send one or more ReadBinary or UpdateBinary commands.

At the end of a session or when the host selects another file, the read and write access rights are initialized.

3.4 NDEF file passwords

The NDEF file passwords protect the read or write access from an RF interface from/to an NDEF file.

Two NDEF file passwords are available for each NDEF file:

- Read password
- Write password

The length of a password is 128 bits (16 bytes).

Note: The delivery state for all passwords = 0x00000000000000000000000000000000.

3.5 Read/Write counter

A 20 bits counter can track the read or write events on the NDEF file.

It benefits from an anti-tearing mechanism, that ensures the consistency of the counter, even if there has been an electrical problem during its increment.

The value of the Read/Write counter can be checked by any application, by reading suitable bytes in System file (see *Section 3.1.4*).

If enabled, the Read/Write counter will be incremented on first event (exclusively Read or Write) which is performed on the NDEF File, inside an RF session (an RF session is entered when SRTAG2KL receives a valid "Select Application" command).

The counter is reset when it is disabled.

Apart from these procedures, there is no way to act on the value of this counter.

The Read/Write counter can be configured through a specific byte in System file (see *Section 3.1.4*).

This configuration byte allows to:

- Enable or disable this counter
- Define if the counter must be incremented on a read or write sequence
- Definitively lock this configuration byte

Warning: Once this configuration byte is locked, it cannot be changed anymore: the counter will behave accordingly.

If enabled, the Read/Write counter will have an impact on the execution time of the event which is countered: the counter increment needs some write cycles of specific EEPROM cells automatically managed by SRTAG2KL, which increase the total time before the response is sent to the reader.

As a consequence, an S(WTX) request can be issued on the command that will increment the counter (see *Section 5.4*).

4 Communication mechanism

This chapter describes the principle of communication between an RF host and the SRTAG2KL device.

4.1 Master and slave

The SRTAG2KL acts as a slave device on the RF channel and therefore waits for a command from the RF host before sending its response.

The RF host shall generate the RF field and the RF commands.

5 RF command sets

This section describes the SRTAG2KL command sets that can be issued by the RF host.

There are three command families:

- the NFC Forum Type 4 Tag command set
- the ISO/IEC 7816-4 command set
- the proprietary command set

The NFC Forum Type 4 Tag command set and the ISO/IEC 7816-4 command set use the I-Block format. For more details about the I-Block format, refer to *Section 5.2: I-Block format*.

Two other command formats exist:

- the commands using the R-Block format
- the commands using the S-Block format

For more details about these formats, refer to the corresponding sections: *Section 5.3: R-Block format* and *Section 5.4: S-Block format*.

This section gives a brief description of the RF host commands. The format of these command sets is the I-Block format.

Table 10 lists the RF command sets.

Table 10. RF command sets

Family command set	Command name	Class byte	Instruction code	Brief description
NFC Forum Type 4 Tag	NDEF Tag Application Select	0x00	0xA4	NDEF Tag Application Select
	CC select	0x00	0xA4	Select the CC file
	NDEF select	0x00	0xA4	Select the NDEF file
	System select	0x00	0xA4	Select the system file
	ReadBinary	0x00	0xB0	Read data from file
	UpdateBinary	0x00	0xD6	Write or erase data to a NDEF file
ISO/IEC 7816-4	Verify	0x00	0x20	Checks the right access of a NDEF file or sends a password
	ChangeReferenceData	0x00	0x24	Change a Read or write password
	EnableVerificationRequirement	0x00	0x28	Activate the password security
	DisableVerificationRequirement	0x00	0x26	Disable the password security
ST Proprietary	EnablePermanentState	0xA2	0x28	Enables the Read Only or Write Only security state
ST Proprietary	ExtendedReadBinary	0xA2	0xB0	Read data from file

5.1 Structure of the command sets

The exchange of data between the RF host and the SRTAG2KL uses three kinds of data formats, called blocks:

- I-Block (Information block): to exchange the command and the response
- R-Block (Receive ready block): to exchange positive or negative acknowledgement
- S-Block (Supervisory block): to use either the Deselect command or the Frame Waiting eXtension (WTX) command or response

This section describes the structure of I-Block, R-block and S-Block. This format is used for the application command set.

5.2 I-Block format

The I-Block is used to exchange data between the RF host and the SRTAG2KL. It is composed of three fields. *Table 11* details the I-Block format.

Table 11. I-Block format

Name	SoD		Payload	EoD
	PCB	DID	-	CRC
Length	1 byte	1 byte	1 to 251 bytes	2 bytes
PCB field				
DID field (optional)				
RF host to SRTAG2KL: C-APDU SRTAG2KL to RF host: R-APDU				
2 CRC bytes				

Table 12. PCB field of the I-Block format

	b7-b6	b5	b4	b3	b2	b1	b0
	0b00	0	0	X	0	1	X
I-Block							
RFU							
Must be set to 0							
DID field is present, if bit is set							
Must be set to 0							
Must be set to 1							
Block number(1)							

1. Follow ISO 14443_4 Block numbering rules (see note)

Note: Block numbering rules:

Reader rules:

Rule A: The Reader block number shall be initialized to 0.

Rule B: When an I-block or an R(ACK) block with a block number equal to the current block number is received, the Reader shall toggle the current block number before optionally sending a block to the SRTAG2KL.

SRTAG2KL rules:

Rule C. The SRTAG2KL block number shall be initialized to 1 at activation.

Rule D. When an I-block is received, the SRTAG2KL shall toggle its block number before sending a block.

Note: The SRTAG2KL may check if the received block number is not in compliance with Reader rules to decide neither to toggle its internal block number nor to send a response block.

Rule E. When an R(ACK) block with a block number not equal to the current SRTAG2KL block number is received, the SRTAG2KL shall toggle its block number before sending a block.

Note: There is no block number toggling when an R(NAK) block is received.

When the RF host sends a command to the SRTAG2KL the format of the payload is the C-APDU.

When the SRTAG2KL sends a command to the RF host, the format of the payload is the R-APDU.

5.2.1 C-APDU: payload format of a command

The C-APDU format is used by the RF host to send a command to the SRTAG2KL. *Table 13* describes its format.

Table 13. C-APDU format

Name	Payload field						
	CLA	INS	P1	P2	L_C	Data	Le
Length	1 byte	1 byte	1 byte	1 byte	1 byte	Lc byte	1 byte
Class byte 0x00: standard command 0xA2: ST command(1)							
Instruction byte							
Param Byte 1							
Param Byte 2							
Number of bytes of the Data field							
Data bytes							
Number of bytes to be read in the SRTAG2KL memory							

1. See *Table 10*

5.2.2 R-APDU: payload format of a response

the SRTAG2KL uses the I-Block format to reply to a command which used the I-Block format. This format is described in *Table 14*.

Table 14. R-APDU format

Name	Payload field		
	Data (optional)	SW1	SW2
Length	Le byte	1 byte	1 byte
Data			
Status byte 1			
Status byte 2			

5.3 R-Block format

The R-Block is used to convey positive or negative acknowledgment between the RF host and the SRTAG2KL.

Table 15. R-Block format

NFC frame	SoD			EoD
	PCB	DID	Payload	CRC
Length	1 byte	1 byte	0 byte	2 bytes
R(ACK) without the DID field: 0xA2 or 0xA3 R(ACK) with the DID field: 0xAA or 0xAB R(NAK) without the DID field: 0xB2 or 0xB3 R(NAK) with the DID field: 0xBA or 0xBB				
DID field (optional)				
-				
2 CRC bytes				

There are two kinds of R-Blocks:

- R(ACK): the acknowledgment block sent by the RF host or by the SRTAG2KL
- R(NAK): the non-acknowledgment block sent by the RF host

Table 16. R-Block detailed format

	b7-b6	b5	b4	b3	b2	b1	b0
	0b10	1	X	X	0	0	X
R-Block							
Must be set to 1.							
0: NAK 1: ACK							
0: DID field is not present 1: DID field is present							
Must be set to 0							
Must be set to 0							
Block number							

5.4 S-Block format

The S-Block is used to exchange control information between a reader and a contactless tag.

Table 17. S-Block format

NFC frame	SoD			EoD
	PCB	DID	Payload	CRC
Length	1 byte	1 byte	1 byte	2 bytes
0xC2: for S(DES) when the DID field is not present 0xCA: for S(DES) when the DID field is present 0xF2: for S(WTX) when the DID field is not present 0xFA: for S(WTX) when the DID field is present				
DID field (optional)				
WTX field (optional)(1)				
2 CRC bytes				

1. This field is present when b5-b4 bits are set to 0b11 (S-Block is a WTX). see *Table 18: S-Block detailed format*.

There are two requests using the S-Block format:

- S(DES): the deselect command
- S(WTX): the Waiting Frame eXtension command or response.

  A Waiting Time eXtension request occurs in RF when the operating time needed by SRTAG2KL is greater than 19.2 ms.

  The WTX field indicates the increase time factor to be used in this command execution (FDTtemp = WTX * 19.2 ms). WTX depends on FWI.

Table 18. S-Block detailed format

	b7-b6	b5-b4	b3	b2	b1	b0
	0b11	X	X	0	1	0
S-Block						
0b00: Deselect 0b11: WTX						
0: DID field is not present 1: DID field is present						
Must be set to 0						
Must be set to 1						
Must be set to 0						

Note: After receiving the deselect command, the session is released and SRTAG2KL enters the Standby power mode.

*In response to a RATS command, SRTAG2KL returns FWI parameter (default frame waiting time used); when SRTAG2KL needs more time for a command execution, it requests a frame waiting time extension by responding 0xF2 0xWTX (Request waiting time = FWI * WTX). If the reader accepts SRTAG2KL request, it acknowledges by sending the command 0xF2 0xWTX. The frame waiting time becomes FWI * WTX for the current command only.*

5.5 CRC of the RF frame

The two CRC bytes check the data transmission between the RF host and the SRTAG2KL. For the RF frame, the CRC is computed on all the data bits in the frame, excluding parity bits, SOF and EOF, and the CRC itself.

The CRC is as defined in ISO/IEC 13239. The initial register content shall be 0x6363 and the register content shall not be inverted after calculation.

5.6 NFC Forum Type 4 Tag protocol

5.6.1 Commands set

SRTAG2KL command set is built to easily support the NFC Forum Type 4 Tag protocol.

Table 19. Command set overview

Command name	Brief description
NDEF Tag Application Select	Select the NDEF Tag Application
Capability Container Select	Select the capability container (CC) file using the Select command
NDEF Select	Select the NDEF file using the Select command.
System File Select	Select the system file using the Select command.

Table 19. Command set overview (continued)

Command name	Brief description
ReadBinary	Read data from a file
UpdateBinary	Write new data to a file

5.6.2 Status and error codes

This section lists the status and the error code of the SRTAG2KL.

Table 20. Status code of the SRTAG2KL

	SW1	SW2	Comment
Value	0x90	0x00	Command completed successfully

Table 21. Error code of the SRTAG2KL

	SW1	SW2	Comment
Length	**1 byte**	**1 byte**	
Value	0x62	0x82	End of file or record reached before reading Le bytes
Value	0x63	0x00	Password is required
Value	0x63	0xCX	Password is incorrect, X further retries allowed (X can take value 0,1, 2)
Value	0x65	0x81	Unsuccessful updating
Value	0x67	0x00	Wrong frame length
Value	0x69	0x81	Cmd is incompatible with the file structure
Value	0x69	0x82	Security status not satisfied
Value	0x69	0x84	Reference data not usable
Value	0x6A	0x80	Incorrect parameters Le or Lc
Value	0x6A	0x82	File or application not found
Value	0x6A	0x84	File overflow (Lc error)
Value	0x6A	0x86	Incorrect P1 or P2 values
Value	0x6D	0x00	INS field not supported
Value	0x6E	0x00	Class not supported

5.6.3 NDEF Tag Application Select command

the RF host shall send this command to activate the NDEF Tag Application.

To activate the NDEF Tag Application, the RF host sends the Select command (see *Table 22*) in addition to the sequence defined in the NFC Forum digital protocol.

Table 22 defines the C-APDU of the Select command to select the NDEF Tag Application (called NDEF Tag Application Select).

Table 22. C-APDU of the NDEF Tag Application Select command

Name	CLA	INS	P1	P2	Lc	Data	Le
	0x00	0xA4	0x04	0x00	0x07	0xD27600 00850101	0x00
Class byte							
Select instruction code							
P1 field							
P2 field							
Number of bytes of data							
Application ID							
Le field							

Table 23 defines the R-APDU of the NDEF Tag Application Select command.

Table 23. R-APDU of the NDEF Tag Application Select command

	Data	SW1	SW2	Comment
Length	-	1 byte	1 byte	-
Value	-	0x90	0x00	Command completed
Value	-	0x6A	0x82	NDEF Tag Application not found
Value	-	0x6D	0x00	Class not supported

Note: For further return codes and definitions, refer to Section 5.6.2: Status and error codes.

5.6.4 Capability Container Select command

The RF host uses the Capability Container Select procedure to select the capability container (CC) file.

The CC file is selected when this command returns "command completed" in the R-APDU. *Table 24* defines the C-APDU of the Select command to select the CC file (called Capability Container Select).

Table 24. C-APDU of the Capability Container Select command

Name	CLA	INS	P1	P2	Lc	Data	Le
	0x00	0xA4	0x00	0x0C	0x02	0xE103	-
Class byte							
Select instruction code							
P1 field							
P2 field							
Number of bytes of data							
CC file ID							
(empty field)							

Table 25 defines the R-APDU of the CC Select command.

Table 25. R-APDU of the Capability Container Select command

	Data	SW1	SW2	Comment
Length	-	1 byte	1 byte	-
Value	-	0x90	0x00	Command completed
Value	-	0x6A	0x82	File or application not found
Value	-	0x6D	0x00	Class not supported

Note: For further return codes and definitions, refer to Section 5.6.2: Status and error codes.

5.6.5 NDEF Select command

The RF host uses the NDEF Select command to select the NDEF file.

The NDEF file is selected when this command returns "command completed" in the R-APDU. *Table 26* defines the C-APDU of the Select command to select the NDEF file (called NDEF Select).

Table 26. C-APDU of the NDEF Select command

Name	CLA	INS	P1	P2	Lc	Data	Le
	0x00	0xA4	0x00	0x0C	0x02	0x0001	-
Class byte							
Select instruction code							
P1 field							
P2 field							
Number of bytes of data							
0x0001: NDEF file							
(empty field)							

Table 27 defines the R-APDU of the NDEF Select command.

Table 27. R-APDU of the NDEF Select command

	Data	SW1	SW2	Comment
Length	-	1 byte	1 byte	-
Value	-	0x90	0x00	Command completed
Value	-	0x6A	0x82	File or application not found

Note: For further return codes and definitions, refer to Section 5.6.2: Status and error codes.

5.6.6 System File Select command

The RF host uses this command to select the system file.

The System file is selected when this command returns "command completed" in the R-APDU.

Table 28 defines the C-APDU of the command to select the System file (called System Select).

Table 28. C-APDU of the System File Select command

Name	CLA	INS	P1	P2	Lc	Data	Le
	0x00	0xA4	0x00	0x0C	0x02	0xE101	-
Class byte							
Select instruction code							
P1 field							
P2 field							
Number of bytes of data							
System file ID							
(empty field)							

Table 29 defines the R-APDU of the System File Select command.

Table 29. R-APDU of the System File Select command

	Data	SW1	SW2	Comment
Length	-	1 byte	1 byte	-
Value	-	0x90	0x00	Command completed
Value	-	0x6A	0x82	System file not found, no data is returned

Note: Note: For further return codes and definitions, refer to Section 5.6.2: Status and error codes.

5.6.7 ReadBinary command

On receiving the ReadBinary command, the SRTAG2KL reads the requested memory field and sends back its value in the R-APDU response.

Before sending a ReadBinary command, a file shall be selected by using a Select command.

The Response of the ReadBinary command is successful when the data to be read is within the selected file [(a)]; in other words, when the sum of P1-P2 and Le fields is equal to or lower than the selected file length.

Table 30 defines the ReadBinary command.

Table 30. C-APDU of the ReadBinary command

Name	CLA	INS	P1 & P2	Lc	Data	Le
	0x00	0xB0	2 bytes	-	-	1 byte
Class byte						
Read instruction code						
Offset in the file selected						
(empty field)						
(empty field)						
Number of bytes to read between 0x01 ≤Le ≤max(Selected File length, 0xFFh)						

Table 31 defines the R-APDU of the ReadBinary command.

Table 31. R-APDU of the ReadBinary command

	Data	SW1	SW2	Comment
Length	-	1 byte	1 byte	-
Value	Content read	0x90	0x00	Command completed
Value	-	0x67	0x00	Wrong length
Value	-	0x69	0x82	Security status not satisfied
Value	-	0x6A	0x82	File or application not found
Value	-	0x6E	0x00	-

Note: For further return codes and definitions, refer to Section 5.6.2: Status and error codes.

a. For more details about CC file, refer to *Section 3.1.2: CC file layout*.
For more details about NDEF file, refer to *Section 3.1.3: NDEF file layout*.
For more details about System file, refer to *Section 3.1.4: System file layout*.

5.6.8 UpdateBinary command

On receiving the UpdateBinary command, the SRTAG2KL writes the data field into the selected file and sends back a status in the R-APDU response. If needed, SRTAG2KL will request a timing extension (see *Section 5.4*).

Before sending an UpdateBinary command, a file shall be selected by issuing a Select command.

Table 32 defines the UpdateBinary command.

Table 32. C-APDU of the UpdateBinary command

Name	CLA	INS	P1 & P2	Lc	Data	Le
	0x00	0xD6	2 bytes	1 byte	Lc bytes	-
Class byte						
Write instruction code						
Offset in the file selected						
Number of bytes of data (0x01 ≤ Lc ≤ 0xF6)						
Data to write in the SRTAG2KL memory						
(empty field)						

Note: Note: For further return codes and definitions, refer to Section 5.6.2: Status and error codes.

Table 33 defines the R-APDU of the UpdateBinary command.

Table 33. R-APDU of the UpdateBinary command

	Data	SW1	SW2	Comment
Length	-	1 byte	1 byte	-
Value	-	0x90	0x00	Command completed
Value	-	0x65	0x81	Unsuccessful updating
Value	-	0x67	0x00	-
Value	-	0x69	0x82	Security status not satisfied
Value	-	0x6A	0x82	File or application not found
Value	-	0x6E	0x00	-

Note: For further return codes and definitions, refer to Status and error codes.

5.7 ISO/IEC 7816-4 commands

The ISO/IEC 7816-4 command set offers some extended features such as the protection of the NDEF file. This command set is used to manage the right access of the NDEF file.

5.7.1 Verify command

The Verify command has two functions:

1. Check if a password is required to access to the NDEF file (the LC field = 0x00).
2. Check that the password embedded in the Verify command allows the access to the memory (the Lc field = 0x10 and the password is present).

When the Lc field if equal to 0x00, the verify command returns a success code (0x90 00) provided that the access to the NDEF file does not require a password. When the access to the NDEF file is protected, the response to the Verify command returns an error code (0x63 00).

When the Lc field equals 0x10, on receiving the Verify command, the SRTAG2KL compares the requested password with the data contained in the request and reports whether the operation has been successful in the response.

Before sending this command, an NDEF file shall be selected by issuing the NDEF Select command. Thus, this command checks the right access condition of the last NDEF file selected.

After a successful command, an access is granted for the whole NDEF file.

Table 34 defines the Verify command.

Table 34. Verify command format

Name	CLA	INS	P1 & P2	Lc	Data	Le
	0x00	0x20	2 bytes	1 byte	Lc bytes	-
Class byte						
Instruction code						
Password identification 0x0001: Read NDEF password transmit 0x0002: Write NDEF password transmit Other: RFU(1)						
0x00: the password is not present 0x10: the password is present in the data field						
Password						
(empty field)						

1. Return ERROR code when used.

Table 35 defines the R-APDU of the Verify command.

Table 35. R-APDU of the Verify command

	Data	SW1	SW2	Comment
Length	-	1 byte	1 byte	-
Value	-	0x90	0x00	Command completed, the password is correct
Value	-	0x69	0x84	The conditions of use are not satisfied (e.g. no NDEF file was selected or Write access equal to FFh (write lock) or read access equal to FEh (read lock)
Value	-	0x69	0x81	Cmd incompatible with file structure
Value	-	0x69	0x82	Security status not satisfied
Value	-	0x6A	0x80	Incorrect parameter in cmd data field
Value	-	0x63	0x00	A password is required
Value	-	0x63	0xCX (1)	The password transmitted is incorrect and X encodes the number of further allowed retries.

1. At each session, the RF host can check a password 3 times.

Note: For further return codes and definitions, refer to Section 5.6.2: Status and error codes.

5.7.2 Change Reference Data command

The Change Reference Data command replaces the read or write password related to the NDEF files previously selected. It can be performed only if the security status satisfies the security attributes for this command.

Before sending this command, the verify command with the correct NDEF write password shall be issued. Thus, this command changes the reference data of the NDEF file.

Table 36 defines the Change Reference Data command.

Table 36. Change reference data command format

Name	CLA	INS	P1 & P2	Lc	Data	Le
	0x00	0x24	2 bytes	0x10	Lc bytes	-
Class byte						
Instruction code						
Password identification 0x0001: Read password transmit 0x0002: Write password transmit Other: RFU(1)						
0x10: the password is present in the data field						
NDEF new file Password						
(empty field)						

1. Return ERROR code when used.

Table 37 defines the R-APDU of the Change Reference Data command.

Table 37. R-APDU of the Change Reference Data command

	Data	SW1	SW2	Comment
Length	0	1 byte	1 byte	-
Value	-	0x90	0x00	Command completed, the access right has been changed
Value	-	0x69	0x81	Cmd is incompatible with the file structure
Value	-	0x65	0x81	Unsuccessful updating
Value	-	0x69	0x82	Security status not satisfied
Value	-	0x6A	0x80	Incorrect param. in file structure
Value	-	0x6A	0x82	File or application not found
Value	-	0x6A	0x86	Incorrect P1 or P2 values

Note: Note: For further return codes and definitions, refer to Section 5.6.2: Status and error codes.

5.7.3 Enable Verification Requirement command

The Enable Verification Requirement command activates the protection by password of the NDEF file. When this command is successful, the read or write access to the NDEF file is protected by a 128-bit password. It can be performed only if the security status satisfies the security attributes for this command.

This command can update the right access of the NDEF file by writing into the EEPROM. In this case, the response timing will be around 5 ms.

Before sending this command, the verify command with the correct NDEF write password shall be issued. Thus, this command changes the access right of the NDEF file.

Table 38 defines the Enable Verification requirement command.

Table 38. Enable Verification Requirement command format

Name	CLA	INS	P1 & P2	Lc	Data	Le
	0x00	0x28	2 bytes	-	-	-
Class byte						
Instruction code						
New security attributes 0x0001: Enable the read protection of the NDEF file 0x0002: Enable the write protection of the NDEF file Other: RFU						
(empty field)						
(empty field)						
(empty field)						

The last five bits identify the password sent in the Verify command.

Table 39 defines the R-APDU of the Enable Verification Requirement command.

Table 39. R-APDU of the Enable Verification Requirement command

	Data	SW1	SW2	Comment
Length	0	1 byte	1 byte	-
Value	-	0x90	0x00	Command completed, the password is correct
Value	-	0x69	0x81	Cmd is incompatible with the file structure
Value	-	0x69	0x82	Security status not satisfied
Value	-	0x6A	0x80	Incorrect param. in cmd data field
Value	-	0x6A	0x82	File or application not found
Value	-	0x6A	0x86	Incorrect P1 or P2 values

Note: Note: For further return codes and definitions, refer to Section 5.6.2: Status and error codes.

5.7.4 Disable Verification Requirement command

The Disable Requirement command deactivates the protection by password of the NDEF file. When this command is successful, the read or write access to the NDEF file is granted without security requirements. It can be performed only if the security status satisfies the security attributes for this command.

Before sending this command, the verify command with the correct NDEF write password shall be issued. Thus, this command changes the access right of the NDEF file.

This command can update the right access of the NDEF file by writing into the EEPROM. In this case, the response timing will be around 6 ms.

Table 40 defines the Disable Verification Requirement command.

Table 40. Disable Verification Requirement command format

Name	CLA	INS	P1 & P2	Lc	Data	Le
	0x00	0x26	2 bytes	-	-	-
Class byte						
Instruction code						
New security attributes 0x0001: Disable the read protection of the NDEF file 0x0002: Disable the write protection of the NDEF file Other: RFU						
(empty filed)						
(empty filed)						
(empty filed)						

Table 41 defines the R-APDU of the Disable Verification Requirement command.

Table 41. R-APDU of the Disable Verification Requirement command

	Data	SW1	SW2	Comment
Length	0	1 byte	1 byte	-
Value	-	0x90	0x00	Command completed, the password is correct
Value	-	0x69	0x81	Cmd is incompatible with the file structure
Value	-	0x69	0x82	Security status not satisfied
Value	-	0x6A	0x80	CC file or System file selected
Value	-	0x6A	0x82	File or application not found
Value	-	0x6A	0x86	Incorrect P1 or P2 values
Value	-	0x65	0x81	Update failed

Note: Note: For further return codes and definitions, refer to Section 5.6.2: Status and error codes.

5.8 ST Proprietary command set

The RF host can be issued with the command set described in this chapter.

5.8.1 ExtendedReadBinary command

On receiving the ExtendedReadBinary command, the SRTAG2KL reads the requested memory field and sends back its value in the R-APDU response.

Before sending an ExtendedReadBinary command, a file shall be selected by issuing an NDEF select command.

The response of the ExtendedReadBinary command will be successful even if the data to be read is beyond the NDEF message. The command returns an error code if the data to be read goes beyond the end of the file.

Table 42. C-APDU of the ExtendedReadBinary command

Name	CLA	INS	P1 & P2	Lc	Data	Le
	0xA2	0xB0	2 bytes	-	-	1 byte
ST Class byte						
Read instruction code						
Offset in the file selected						
(empty field)						
(empty field)						
Number of bytes to read between 0x01 ≤ Le ≤ 0xFF						

Table 43 defines the R-APDU of the read binary command.

Table 43. R-APDU of the ExtendedReadBinary command

	Data	SW1	SW2	comment
Length	Le bytes	1 byte	1 byte	-
Value	Content read	0x90	0x00	Command completed
Value	-	0x67	0x00	Wrong length
Value	-	0x69	0x82	Security status not satisfied
Value	-	0x6A	0x82	File or application not found
Value	-	0x6A	0x86	Incorrect P1 or P2 values

Note: Note: For further return codes and definitions, refer to Section 5.6.2: Status and error codes.

5.8.2 EnablePermanentState command

The command configures the NDEF file to the ReadOnly or to the WriteOnly State.

This command can update the right access to the NDEF file by writing into the EEPROM. In this case, the response timing will be around 6 ms.

Table 44 defines the EnablePermanentState requirement command.

Table 44. EnablePermanentState command format

Name	CLA	INS	P1 & P2	Lc	Data	Le
	0xA2	0x28	2 bytes	-	-	-
Class byte						
Instruction code						
New security attributes 0x0001: Lock the NDEF file in read mode 0x0002: Lock the NDEF file in write mode Other: RFU						
(empty field)						
(empty field)						
(empty field)						

Table 45 defines the R-APDU of the EnablePermanentState command.

Table 45. R-APDU table of the EnablePermanentState command

	Data	SW1	SW2	comment
Length	-	1 byte	1 byte	-
Value	-	0x90	0x00	Command completed
Value	-	0x65	0x81	Update failed
Value	-	0x69	0x82	Security status not satisfied

Table 45. R-APDU table of the EnablePermanentState command (continued)

	Data	SW1	SW2	comment
Value	-	0x6A	0x82	File or application not found
Value	-	0x6A	0x86	Incorrect P1 or P2 values

Note: For further return codes and definitions, refer to Section 5.6.2: Status and error codes.

5.9 Specific RF command set

This section describes the command set that can be issued only by the RF host.

5.9.1 Anticollision command set

Table 46 lists the commands that can be issued only by the RF host. The format of these commands is described in the NFC Forum Digital Protocol specification.

Table 46. Commands issues by the RF host

Family command set	Command name	Instruction code
NFC-A technology	ALL_REQ	0x52 (1)
	SENS_REQ	0x26 (1)
	SDD_REQ	0x93 or 0x95
	SEL_REQ	0x93 or 0x95
	SLP_REQ	0x50

1. Code on 7 bits.

Note: In response to a SDD_REQ Command with a SEL_PAR value equal to 20h, SRTAG2KL in the Operating Field transmit the requested cascade level of their NFCID1 (NFCID1 CLn, with n=1 or 2). The NFCID1 of SRTAG2KL consists of 7 bytes. The length of the Response containing a complete NFCID1 cascade level (i.e., NFCID1 CL1, or NFCID1 CL2) is always 5 bytes. The coding of the Response depends on the value of the SEL_CMD byte and the size of the NFCID1.

Refer to example below for more details .

Table 47. Example of anticollision sequence

Command	Code	Comment	Response	Code	Comment
SENS_REQ or ALL-REQ	26	-	ATQA	42 00	UID double size bit frame anticollision
	52				
SDD_REQ 1	93 20	NVB 20 Number Valid bit (2 bytes Code & NVB)		CT uid1 uid2 uid3 BCC	CT Cascade Tag “0x88” (UID 7bytes) BCC Block Check Character (XOR previous Bytes)

Table 47. Example of anticollision sequence (continued)

Command	Code	Comment	Response	Code	Comment
SEL_REQ 1	93 70 CT uid1 uid2 uid3 BBC	NVB 70 (cmd NVB Uid lower bytes) CT Cascade Tag “0x88”	SAK & CRC	04 DAD7	UID Not complete
SDD_REQ 2	95 20	NVB 20 Number Valid bit (2 bytes Code & NVB)	-	uid4 uid5 uid6 uid7 BCC	(UID 7bytes) BCC Block Check Character (XOR previous Bytes)
SEL_REQ 1	95 70 uid4 uid5 uid6 uid7 BBC	NVB 70 (cmd NVB Uid Upper bytes)	SAK & CRC	20 FC70	UID complete

5.9.2 RATS command and ATS response

RATS command and ATS response are used for NFC Forum Type 4A Tag Platform Device Activation (as defined in NFC Forum Digital Protocol specification).

Table 48 details the RATS command. This command shall be sent after the anticollision process.

Table 48. RATS command

Name	INS	Param		CRC
Byte field	0xE0	1 byte		2 bytes
Bit field		b7-b4	b3-b0	
Instruction code				
FSDI				
DID (0 ≤ DID ≤ 14)				
2 CRC bytes				

The FSDI field codes the FSD that defines the maximum size that an RF host is able to receive. *Table 49* gives the conversion from FDSI to FSD.

Table 49. Conversion from FDSI to FSD

FSDI	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9h-0xE	0xF
FSD	16	24	32	40	48	64	96	128	256	RFU	256

The DID field defines the value of the addressed SRTAG2KL.

Table 50. ATS response

Name	TL	T0	TA(1)	TB(1)		TC(1)	CRC
Byte field	0x05	0x75	0x80	0x60		0x02	2 bytes
Bit field				b8-b5	b4-b1		
Length of the ATS response							
FSCI = 5 => FSC = 64 bytes							
The maximum ascending data rate is 106 kbps The maximum descending data rate is 106 kbps							
FWI field (FWI = 6 => FWT = 19.2 ms)							
SFGI field (SFGI = 0 => SFGT =302 µs)							
The DID is supported							
2 CRC bytes							

The FSCI codes the FSC which stands for the maximum frame size that the SRTAG2KL is able to receive. The SRTAG2KL is able to receive up to 64 bytes of command. If the RF host sends a command with more than 64 bytes, the SRTAG2KL will not be able to treat the command and will not reply.

The FWI which stands for the Frame Waiting time Integer codes the FWT. This time corresponds to the maximum duration while an RF host shall send before sending the next command.

The SFGI which stands for the Start-up Frame Guard Time is the minimum time that the reader shall wait after receiving the response of the SRTAG2KL.

5.9.3 PPS command & response[b]

PPS (Protocol and Parameter Selection) command and response are defined in ISO/IEC 14443-4, in the Protocol Activation of PICC Type A.

The PPS command allows to change the data rates of the ascending (RF host to SRTAG2KL) and descending (SRTAG2KL to RF host) data rates. Usage of this command is optional, SRTAG2KL only supports 106 Kb/s in both direction.

Table 51. PPS command

	Name	INS (PPSS)		PPS0	PPS1			CRC
-	Byte field	0xDX		0x11	1 byte			2 bytes
	Bit field	b7-b4	b3-b0		0b0000	b3-b2	b1-b0	
INS	Instruction code							
	DID							
	PPS1 is present							
PPS1	RFU							
	Descending data rate (106 kb/s) = 0b00							
	Ascending data rate (106 kb/s) = 0b00							
	2 CRC bytes							

The ascending and descending data rates shall be coded as described in *Table 52*.

Table 52. Ascending and descending data rate coding

Value	0b00	0b01	0b10	0b11
Data rate	106 kbps	RFU	RFU	RFU

When the SRTAG2KL is able to change both data rates, it returns the following response. The data rate of this response is 106 kbps; then, the SRTAG2KL changes the ascending and descending data rates.

Table 53 gives the details sof the PPS response.

b. Not useful in case of SRTAG2KL which only support a Data Rate of 106 Kb/s in both direction.

Table 53. PPS response

Name	RESPONSE (PPSS)		CRC
Byte field	0xDX		2 bytes
Bit field	b8-b5	b4-b1	
Response code			
DID field			
2 CRC bytes			

6 RF device operation

6.1 Anticollision and Device Activation command set for the RF interface

The SRTAG2KL device supports the command set defined in the NFC-A Technology and the Type 4A Tag Platform chapters of the NFC Digital Protocol V1.0 specification.

6.2 Open an RFsession

Once the RF host has terminated the anticollision procedure and retrieve the ATS response, it shall send the SelectApplication command. The SRTAG2KL will open an RF session. At this point, the RF host can send the applicative command set.

6.3 Close an RFsession

The RF host can close the RF session by issuing one of these methods:

- send an S(DES) command
- turn off the RF field

6.4 Applicative command set

The applicative command set is composed of the following command sets:

- the NFC Forum Type 4 Tag command set
- the ISO/IEC 7816-4 command set
- the proprietary command set

7 Functional procedures

This section describes some procedure to access the memory or manage its protection.

7.1 Selection of an NDEF message

The RF host shall use this procedure to detect the NDEF message inside an SRTAG2KL.

The NDEF detection procedure is as follows:

1. Open an RF session
2. Send the SelectNDEFTagApplication command
3. Select the CC file
4. Read the CC file
5. Select the NDEF file.

7.2 Reading of an NDEF message

The RF host executes the NDEF read procedure to read the NDEF file.

1. Detect successfully the NDEF file using the NDEF detection procedure
2. Check that the read access without any security is granted for the NDEF file from the information provided by the CC file
3. Select the NDEF file
4. Read the NDEF file.

7.3 Reading a locked NDEF file

The RF host executes this procedure to read an NDEF file which has been locked previously.

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Present the Read password by using the Verify command
4. Read the data in the NDEF file.

7.4 Locking an NDEF file

The RF host executes this procedure to protect an NDEF file.

1. Select the NDEF Tag Application
2. Check the right access provided by the CC file
3. Select the NDEF file
4. Present the NDEF file Write password by using the Verify command
5. Lock the NDEF file by sending the Enable verification command.

7.5 Unlocking an NDEF file

The RF host executes this procedure to read an NDEF file which has been locked previously.

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Present the NDEF file Write password by using the Verify command
4. Unlock the NDEF file by sending the Disable verification command.

7.6 Reaching the read-only state for an NDEF file

The RF host executes this procedure to read an NDEF file which has been locked previously.

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Transmit the NDEF file Write password by using the Verify command
4. Send an EnablePermanentState command.

7.7 Changing a File type Procedure

The RF host executes this procedure to change the File Type of a file for which all access rights were previously granted.

1. Select the NDEF Tag Application
2. Select the File to be modified
3. Set the File Length to 0x00 using the UpdateBinary command
4. Send an UpdateFileType command with the New file Type as data.

8 UID: Unique identifier

The SRTAG2KL is uniquely identified by a 7 bytes unique identifier (UID). The UID is a read-only code and comprises:

- The IC manufacturer code on 1 byte (0x02 for STMicroelectronics).
- The Product code on 1 byte.
- A device number on 5 bytes.

Table 54 describes the UID format.

Table 54. UID format

	0x02	0xE2	5 bytes
IC manufacturer code			
SRTAG2KL product code			
Device number			

9 Maximum rating

Stressing the device above the rating listed in *Table 55* may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect the device reliability.

Table 55. Absolute maximum ratings

Symbol	Parameter		Min.	Max.	Unit
T_A	Ambient operating temperature		-40	85	°C
T_{STG}, h_{STG}, t_{STG}	Storage conditions	Sawn wafer on UV tape	15	25	°C
				6 (1)	months
			kept in its original packing form		
T_{STG}	Storage temperature	Sawn Bumped Wafer (kept in its antistatic bag)	15	25	°C
	Storage time			6	months
I_{CC} (2)	RF supply current AC0 - AC1		-	100	mA
V_{MAX_1} (2)	RF input voltage amplitude between AC0 and AC1, V_{SS} pad left floating	VAC0-VAC1 (Peak to Peak)	-	10	V
V_{ESD}	Electrostatic discharge voltage (human body model) (3)	AC0-AC1	-	1000	V

1. Counted from ST shipment date.
2. Based on characterization, not tested in production. Maximum absorbed power = 100 mW @ 7.5 A/m
3. AEC-Q100-002 (compliant with JEDEC Std JESD22-A114A, C1 = 100 pF, R1 = 1500 Ω, R2 = 500 Ω)

10 RF electrical parameters

This section summarizes the operating and measurement conditions, and the DC and AC characteristics of the device in RF mode.

The parameters in the DC and AC characteristics tables that follow are derived from tests performed under the Measurement Conditions summarized in the relevant tables. Designers should check that the operating conditions in their circuit match the measurement conditions when relying on the quoted parameters.

Table 56. Default operating conditions

Symbol	Parameter	Min.	Max.	Unit
T_A	Ambient operating temperature	–40	85	°C

Table 57. RF characteristics (1)

Symbol	Parameter	Condition	Min	Typ	Max	Unit
f_C	External RF signal frequency		13.553	13.56	13.567	MHz
H_ISO	Operating field according to ISO	T_A = 0 °C to 50 °C	1500	-	7500	mA/m
H_Extended	Operating field in extended temperature range	T_A = -40 °C to 85 °C	100	-	7500	mA/m
H_{min}	Field detect, Set-up field(1)	T_A = -40 °C to 85 °C	-	50	-	mA/m
$MI_{CARRIER}$	100% carrier modulation index	MI=(A-B)/(A+B)	90	-	100	%
t_1	Pause A length	-	$28/f_C$	-	$40.5/f_C$	µs
t_2	Pause A low time	-	$7/f_C$	-	t1	µs
t_3	Pause A rise time	-	1.5xt4	-	$16/f_C$	µs
t_4	Pause A rise time section	-	0	-	$6/f_C$	µs
$t_{MIN\ CD}$	Minimum time from carrier generation to first data	From H-field min	-	-	5	ms
W_t	RF write time (including internal Verify) for one page	-	-	4.468(2)	-	ms
C_{TUN} /5 (3)	Internal tuning capacitor(4)	f_C = 13.56 MHz	45	50	55	pF
t_{RF_OFF}	RF OFF time	Chip reset	-	-	0.1	ms

1. All timing characterizations were performed on a reference antenna with the following characteristics:
   External size: 75 mm x 48 mm
   Number of turns: 4
   Width of conductor: 0.5 mm
   Space between two conductors: 0.5 mm
   Value of the tuning capacitor: 50 pF (SRTAG2KL)
   Value of the coil: 2.5 µH
   Tuning frequency: 14.2 MHz.
2. Time between command EOF and Response SOF when Updating NDEF message Length
3. See */5 = 50 pF*.
4. Characterized only, at room temperature only, measured at VAC0-VAC1 = 2 V peak to peak at 13.56 MHz.

11 Part numbering

Table 58. Ordering information scheme for packaged devices

Example: SRTAG 2K L- SB12 /5

Device type

SRTAG = Short range tag

Memory size

2K = memory size in Kbits

Device feature

L- = tag (no digital output)

Package

MH = UFDFPN5

SB12 = 120 µm ± 15 µm bumped and sawn inkless wafer on 8-inch frame

Device grade

6 = industrial: device tested with standard test flow over –40 to 85 °C
(No parameter for SB12)

Option

T = Tape and reel packing
(No parameter for SB12)

Capacitance

/5 = 50 pF

Note: Parts marked as "ES", "E" or accompanied by an Engineering Sample notification letter, are not yet qualified and therefore not yet ready to be used in production and any consequences deriving from such usage will not be at ST charge. In no event, ST will be liable for any customer usage of these engineering samples in production. ST Quality has to be contacted prior to any decision to use these Engineering samples to run qualification activity.

12 Revision history

Table 59. Document revision history

Date	Revision	Changes
28-Oct-2014	1	Initial release.
16-Jan-2015	2	Added note and updated *Table 58: Ordering information scheme for packaged devices*

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