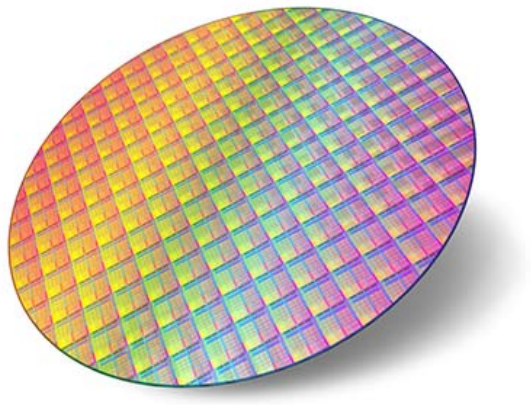
ST25TA64K

NFC Forum Type 4 Tag IC with 64-Kbit EEPROM

Datasheet - production data



Wafer (SB12I)

Description

The ST25TA64K device is an NFC tag IC embedding an EEPROM memory. It can be operated from a 13.56 MHz RFID reader or an NFC phone.

The RF protocol is compatible with ISO/IEC 14443 Type A and NFC Forum Type 4 Tag.

Features

Contactless interface

- NFC Forum Type 4 Tag
- ISO/IEC 14443 Type A
- 106 Kbps data rate
- Internal tuning capacitance: 25 pF

Memory

- 8-Kbyte (64-kbit) EEPROM
- Supports NDEF data structure
- Data retention: 200 years
- Endurance: 1 million erase-write cycles
- Reads up to 246 bytes in a single command
- Writes up to 246 bytes in a single command
- 7-byte unique identifier (UID)
- 128-bit password protection

This is information on a product in full production. www.st.com

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1 Functional description

The ST25TA64K device is a dynamic NFC/RFID tag that can be accessed from the RF interface. The RF interface is based on the ISO/IEC 14443 Type A standard.

The ST25TA64K is compatible with the NFC Forum Type 4 Tag specifications and supports all corresponding commands.

Figure 1 shows the block diagram of the ST25TA64K device.

Figure 1. ST25TA64K block diagram

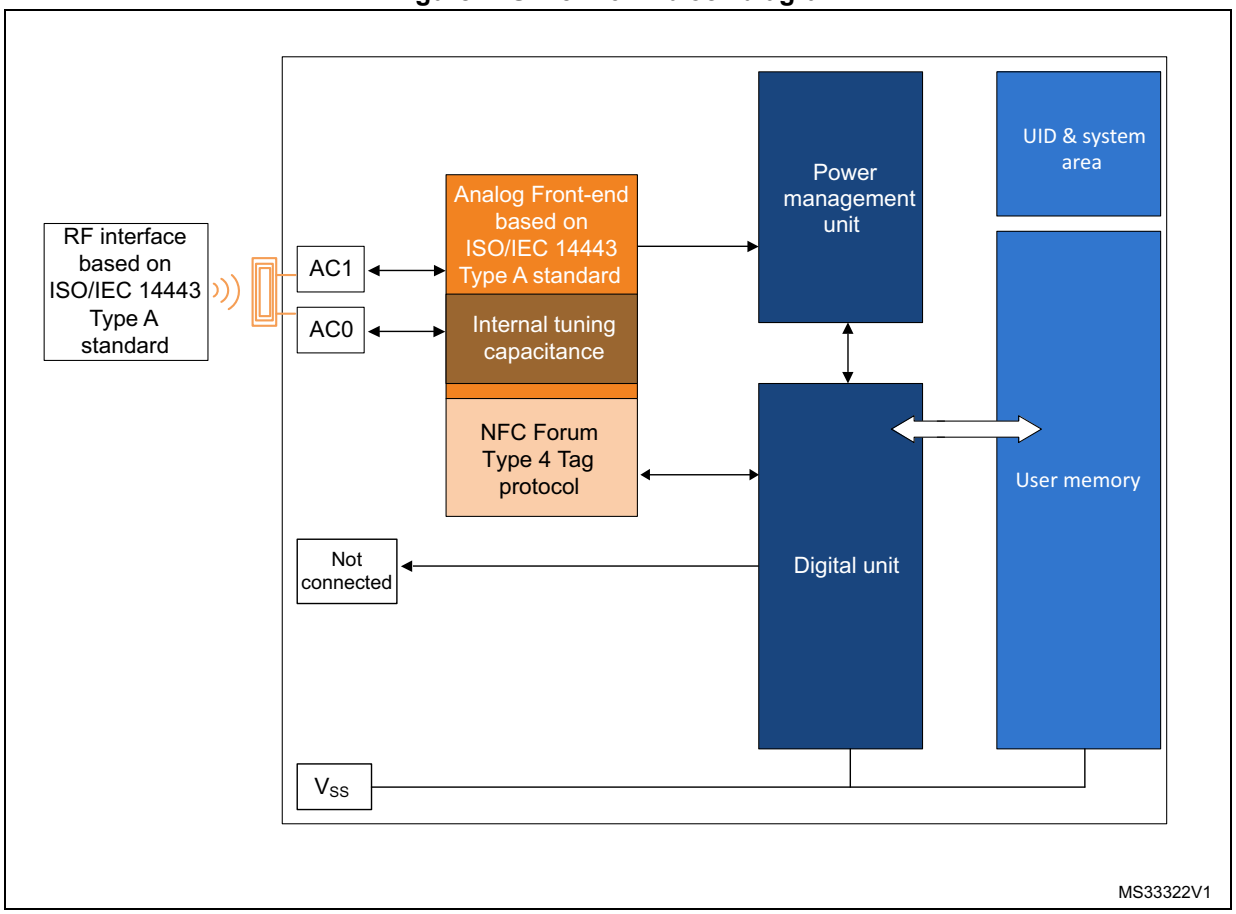


Table 1. Signal names

Signal name	Function	Direction
AC0, AC1	Antenna coils	-

1.1 Functional modes

The ST25TA64K has just one functional mode available (see *Table 2*).

Table 2. Functional mode

Mode	Supply source	Comments
Tag mode	RF field only	The interface is connected

1.1.1 Tag mode

The ST25TA64K is supplied by the RF field and can communicate with an RF host (RFID reader or an NFC phone). The User memory can only 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 ST25TA64K memory management

3.1 Memory structure

The ST25TA64K supports the NDEF Tag Application as defined in the NFC Forum Type 4 Tag. The ST25TA64K is composed of three files:

- one Capability Container file;
- one NDEF file;
- one System file: this is an ST-proprietary file.

The System file contains some information on the configuration of the ST25TA64K device. The CC file gives some information about the ST25TA64K 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 ST25TA64K 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, Read Access and Write Access fields can be changed by the RF host through a specific process (refer to *Section 7: Functional procedures*).

Table 4. CC file layout for one NDEF file

File offset	Meaning	Value	Comments
0x0000	Number of bytes of 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	0x00F6	246 bytes
0x0005	Maximum number of bytes that can be written	0x00F6	246 bytes

Table 4. CC file layout for one 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		0x2000	Maximum NDEF file size
0x000D		0x00(2)	Read access
0x000E		0x00(2)	Write access

1. According to the reader.
2. Delivery state.

3.1.3 NDEF file layout

The NDEF file contains the NDEF message that 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 ST25TA64K device does not check if its value is relevant vs the data written by the RF host. The ST25TA64K device uses the NDEF Message Length, e. g. the standard read can be processed only inside the NDEF message; otherwise, the ST25TA64K 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
...	...	...	...	...
...	...	...	...	...
...	...	...	...	...
0x1FFC	...	...	...	User data

3.1.4 System file layout

The system file specifies the configuration of the ST25TA64K. *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	RF	-	0x0012
0x0002	-	1	RF	-	0x01
0x0003	-	1	RF	-	0x00

Table 6. Field list (continued)

File offset	Field name	Number of bytes	Read access	Write access	Delivery state
0x0004	ST reserved	1	RF	-	0x11
0x0005	ST reserved	1	RF	-	0x00
0x0006	-	1	RF	-	-
0x0007	NDEF File number (RFU)	1	RF	none	0x00
0x0008	UID	7	RF	none	0x02C4 xx xx xx xx xx(1)
0x000F	Memory Size	2	RF	none	0x1FFF
0x0011	Product Code	1	RF	none	0xC4

1. x values are defined by ST to insure UID unicity.

3.2 Read and write access rights to the memory

An 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 ST25TA64K device before reading a read-locked NDEF file.

The write password shall be present on the ST25TA64K 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 7. 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 8. Write access right

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

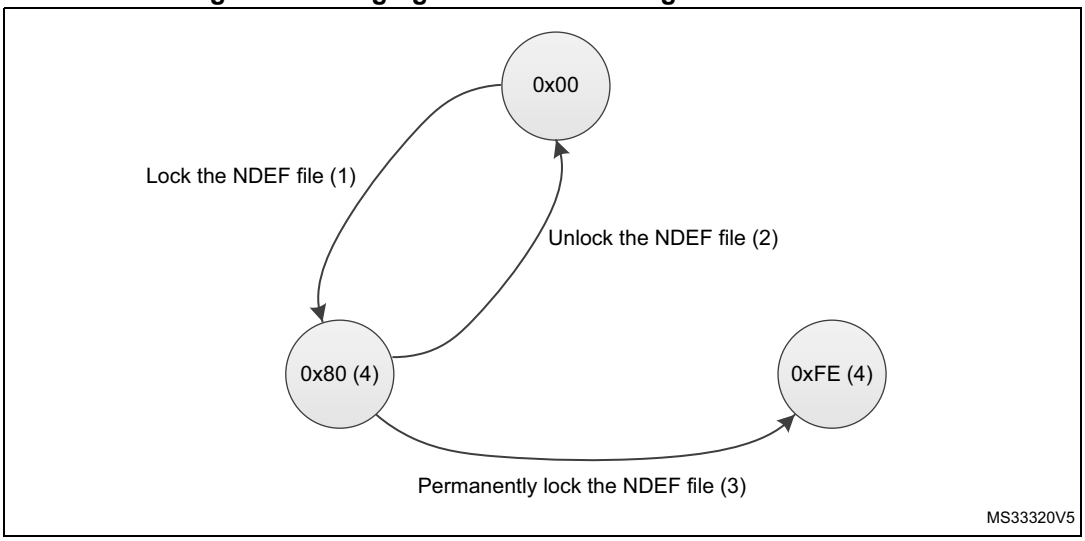
1. The write password shall be sent before writing in the NDEF file.

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

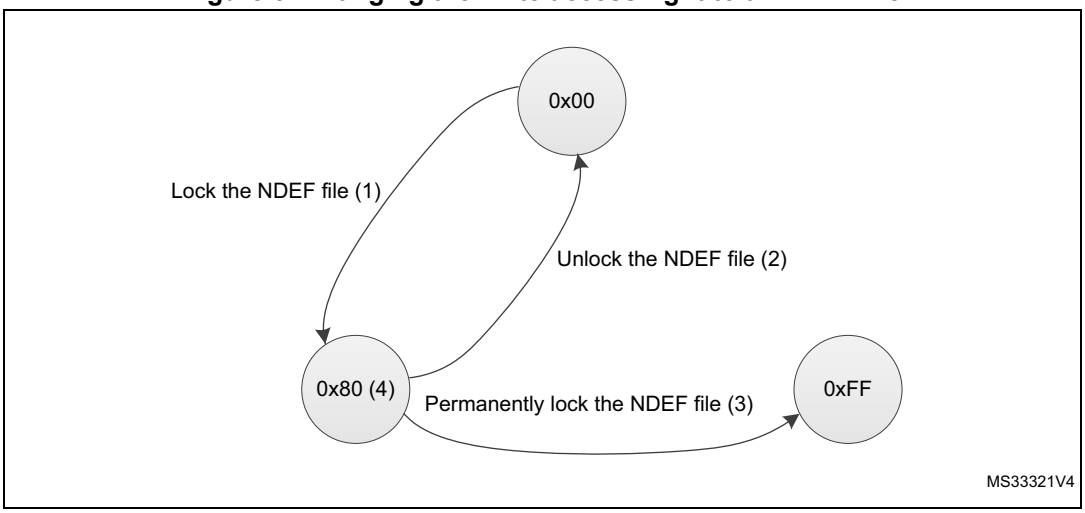


1. See the procedure to lock the read access (*Section 7.4: Locking an NDEF file*).
2. See the procedure to unlock the read access (*Section 7.5: Unlocking an NDEF file*).
3. See the procedure to permanently lock the read access (*Section 7.6: Reaching the read-only state for an NDEF file*).
4. Proprietary 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 is 0x00000000000000000000000000000000.

4 Communication mechanism

This chapter describes the principle of communication between an RF host and the ST25TA64K device.

4.1 Master and slave

The ST25TA64K 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 ST25TA64K 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 9 lists the RF command sets.

Table 9. 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	Selects the CC file
	NDEF select	0x00	0xA4	Selects the NDEF file
	System select	0x00	0xA4	Selects the system file
	ReadBinary	0x00	0xB0	Reads data from file
	UpdateBinary	0x00	0xD6	Writes or erases 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	Changes a Read or write password
	EnableVerificationRequirement	0x00	0x28	Activates the password security
	DisableVerificationRequirement	0x00	0x26	Disables the password security

Table 9. RF command sets (continued)

Family command set	Command name	Class byte	Instruction code	Brief description
ST proprietary	EnablePermanentState	0xA2	0x28	Enables the Read Only or Write Only security state
	ExtendedReadBinary	0xA2	0xB0	Reads data from file
	UpdateFileType	0xA2	0xD6	Sets file type to NDEF or proprietary

5.1 Structure of the command sets

The exchange of data between the RF host and the ST25TA64K uses three kinds of data formats, called blocks:

- I-Block: to exchange the command and the response
- R-Block: to exchange positive or negative acknowledgment
- S-Block: to use either the Deselect command or the Frame Waiting eXtension (WTX) command or response

This section describes the structure of the 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 ST25TA64K. It is composed of three fields. *Table 10* details the I-Block format.

Table 10. 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 ST25TA64K: C-APDU ST25TA64K to RF host: R-APDU				
2 CRC bytes				

Table 11. 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, if bit is set							
Must be set to 0							
Must be set to 1							
Block number							

When the RF host sends a command to the ST25TA64K the format of the payload is the C-APDU.

When the ST25TA64K 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 ST25TA64K. *Table 12* describes its format.

Table 12. C-APDU format

Name	Payload field						
	CLA	INS	P1	P2	LC	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							
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 ST25TA64K memory							

5.2.2 R-APDU: payload format of a response

The ST25TA64K uses the I-Block format to reply to a command that used the I-Block format. This format is described in *Table 13*.

Table 13. 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 ST25TA64K.

Table 14. R-Block format

PCB	CRC
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 0xB3 R(NAK) with the DID field: 0xBA 0xBB	2 CRC bytes

There are two kinds of R-Blocks:

- R(ACK): the acknowledgment block sent by the RF host or by the ST25TA64K
- R(NAK): the non-acknowledgment block sent by the RF host or by the ST25TA64K

Table 15. R-Block detailed format

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

5.4 S-Block format

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

Table 16. S-Block format

NFC frame	SoD		Payload	EoD
	PCB	DID	-	CRC
Length	1 byte	1 byte	0 to 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 (1)				
2 CRC bytes				

1. This field is present when b5-b4 bits are set to 0b11 (S-Block is a WTX). see *Table 17: 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.

Table 17. 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						
-						
RFU						
RFU						

Note: After receiving the deselect command, the session is released and ST25TA64K enters the Standby power mode.

*In response to a RATS command, ST25TA64K returns FWI parameter (default frame waiting time used); when ST25TA64K 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 ST25TA64K 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 ST25TA64K. 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

Table 18. 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
System File Select	Select the system file
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 ST25TA64K.

Table 19. Status code of the ST25TA64K

	SW1	SW2	Comment
Value	0x90	0x00	Command completed successfully

Table 20. Error codes of the ST25TA64K

	SW1	SW2	Comment
Length	1 byte	1 byte	
Value	0x62	0x80	File overflow (Le error)
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

Table 20. Error codes of the ST25TA64K (continued)

	SW1	SW2	Comment
Length	1 byte	1 byte	
Value	0x67	0x00	Wrong length
Value	0x69	0x81	Command 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 21*) in addition to the sequence defined in the NFC Forum digital protocol.

Table 21 defines the C-APDU of the Select command to select the NDEF Tag Application (called NDEF Tag Application Select).

Table 21. C-APDU of the NDEF Tag Application Select command

Name	CLA	INS	P1	P2	Lc	Data	Le
-	0x00	0xA4	0x04	0x00	0x07	0xD2760000850101	0x00
Class byte							
Select instruction code							
P1 field							
P2 field							
Number of bytes of data							
Application ID							
Le field							

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

Table 22. 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

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 23* defines the C-APDU of the Select command to select the CC file (called Capability Container Select).

Table 23. 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							
-							

Table 24 defines the R-APDU of the CC Select command.

Table 24. 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

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 25* defines the C-APDU of the Select command to select the NDEF file (called NDEF Select).

Table 25. C-APDU of the NDEF Select command

Name	CLA	INS	P1	P2	Lc	Data	Le
-	0x00	0xA4	0x00	0x0C	0x02	0x000X	-
Class byte							
Select instruction code							
P1 field							
P2 field							
Number of bytes of data							
0x0001: first NDEF file							
-							

Table 26 defines the R-APDU of the NDEF Select command.

Table 26. 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

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

Table 27. 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							
-							

Table 28 defines the R-APDU of the System File Select command.

Table 28. 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	Capability container not found, no data is returned

5.6.7 ReadBinary command

On receiving the ReadBinary command, the ST25TA64K 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 29 defines the ReadBinary command.

Table 29. 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						
-						
-						
Number of bytes to read between 0x01 ≤ Le ≤ max(Selected File length, 0xF6)						

Table 30 defines the R-APDU of the ReadBinary command.

Table 30. R-APDU of the ReadBinary command

	Data	SW1	SW2	Comment
Length	-	1 byte	1 byte	-
Value	Content read	0x90	0x00	Command completed

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*.

Table 30. R-APDU of the ReadBinary command (continued)

	Data	SW1	SW2	Comment
Value	-	0x67	0x00	Wrong length
Value	-	0x69	0x82	Security status not satisfied
Value	-	0x6A	0x82	File or application not found
Value	-	0x6E	0x00	Class not supported

5.6.8 UpdateBinary command

On receiving the UpdateBinary command, the ST25TA64K writes the data field into the selected file and sends back a status in the R-APDU response.

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

Table 31 defines the UpdateBinary command.

Table 31. 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 ST25TA64K memory						
-						

Table 32 defines the R-APDU of the UpdateBinary command.

Table 32. 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	Wrong length
Value	-	0x69	0x82	Security status not satisfied
Value	-	0x6A	0x82	File or application not found
Value	-	0x6E	0x00	Class not supported

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 ST25TA64K 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 33 defines the Verify command.

Table 33. 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						
0x00: the password is not present 0x10: the password is present in the data field						
Password						
-						

Table 34 defines the R-APDU of the Verify command.

Table 34. 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	0x85	The conditions of use are not satisfied (e.g. no NDEF file was selected)
Value	-	0x69	0x81	Command incompatible with file structure
Value	-	0x69	0x82	Security status not satisfied
Value	-	0x6A	0x80	Incorrect parameter in command 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.
Value	-	0x6E	0x00	Class not supported

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

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 35 defines the Change Reference Data command.

Table 35. Change reference data command format

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

Table 36 defines the R-APDU of the Change Reference Data command.

Table 36. 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	Command is incompatible with the file structure
Value	-	0x65	0x81	Unsuccessful updating
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	-	0x6E	0x00	Class not supported

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 37 defines the Enable Verification requirement command.

Table 37. 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						
-						
-						
-						

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

Table 38 defines the R-APDU of the Enable Verification Requirement command.

Table 38. 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	Command 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

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 39 defines the Disable Verification Requirement command.

Table 39. 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						
-						
-						
-						

Table 40 defines the R-APDU of the Disable Verification Requirement command.

Table 40. 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	Command 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	-	0x6E	0x00	Class not supported
Value	-	0x65	0x81	Update failed

5.8 ST proprietary command set

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

5.8.1 ExtendedReadBinary command

On receiving the ExtendedReadBinary command, the ST25TA64K 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 41. C-APDU of the ExtendedReadBinary command

Name	CLA	INS	P1 & P2	Lc	Data	Le
Length	0xA2	0xB0	2 bytes	-	-	1 byte
ST Class byte						
Read instruction code						
Offset in the file selected						
-						
-						
Number of bytes to read between 0x01 ≤ Le ≤ 0xF6						

Table 42 defines the R-APDU of the read binary command.

Table 42. 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
Value	-	0x6E	0x00	Class not supported

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 43 defines the EnablePermanentState requirement command.

Table 43. EnablePermanentState command format

Name	CLA	INS	P1 & P2	Lc	Data	Le
Length	0xA2	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						
-						
-						
-						

Table 44 defines the R-APDU of the EnablePermanentState command.

Table 44. 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	-	0x67	0x00	Wrong length
Value	-	0x69	0x82	Security status not satisfied

Table 44. R-APDU table of the EnablePermanentState command (continued)

	Data	SW1	SW2	Comment
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	-	0x6E	0x00	Class not supported

5.8.3 UpdateFileType command

This command allows the user to modify the file type of a selected file to Proprietary file (0x05) or NDEF file (0x04).

The command is executed only when the application and the file are selected and the file length and access right have previously been set to 0X00h (message invalid, all access rights granted).

This command will update the file type located in the CC file by writing in the EEPROM. In this case the response timing will be approximately 6 ms.

Before sending this command, an NDEF file shall be selected by issuing the NDEF Select command.

Table 45 defines the UpdateFileType command.

Table 45. UpdateFileType command format

Name	CLA	INS	P1	P2	Lc	Data	Le
Length	0xA2	0xD6	0x00	0x00	0x01	0x04 or 0x05	-
Class byte							
Instruction code							
P1 field							
P2 field							
Number of data bytes							
File type							
-							

Table 46 defines the R-APDU of the UpdateFileType command.

Table 46. R-APDU table of the UpdateFileType command

	Data	SW1	SW2	Comment
Length	-	1 byte	1 byte	-
Value	-	0x90	0x00	Command completed
Value	-	0x69	0x82	Security status not satisfied
Value	-	0x6A	0x80	CC file or System file selected
Value	-	0x6A	0x82	File or application not found

Table 46. R-APDU table of the UpdateFileType command (continued)

	Data	SW1	SW2	Comment
Value	-	0x6A	0x86	Incorrect P1 or P2 values
Value	-	0x6A	0x86	Incorrect P1 or P2 values
Value	-	0x6E	0x00	Class not supported

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 47 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 47. 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 or 0x97
	SEL_REQ	0x93 or 0x95 or 0x97
	SLP_REQ	0x50

1. Code on 7 bits.

Note: In response to a SDD_REQ Command with a SEL_PAR value equal to 20h, the ST25TA64Ks in the Operating Field transmit the requested cascade level of their NFCID1 (NFCID1 CLn, with n = 1 or 2). The NFCID1 of the ST25TA64K 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 the example in Table 48 for more details.

Table 48. Example of anticollision sequence

Command	Code	Comment	Response	Code	Comment
SENS_REQ or ALL-REQ	26 52	-	ATQA	42 00	UID double size bit frame anticollision
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)
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

Table 48. Example of anticollision sequence (continued)

Command	Code	Comment	Response	Code	Comment
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 49 details the RATS command. This command shall be sent after the anticollision process.

Table 49. 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, which defines the maximum size that an RF host is able to receive. *Table 50* gives the conversion from FSDI to FSD.

Table 50. Conversion from FSDI 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 (Dynamic ID, optionally affected to the ST25TA64K by the host to address ST25TA64K in all commands) field defines the value of the addressed ST25TA64K. If DID is not ‘0’, the ST25TA64K will ignore the command if it contains a DID different from the one affected to it during RATS.

Table 51. ATS response

Name	TL	T0	TA(1)	TB(1)		TC(1)	CRC
Byte field	0x05	0x78	1 byte	1 byte		0x02	2 bytes
Bit field	-	-	-	b8-b5	b4-b1	-	-
Length of the ATS response							
FSCI = 256 bytes							
The maximum ascending data rate is 106 kbps The maximum descending data rate is 106 kbps							
FWI field (155 ms when TB = 0x90)							
SFGI field (302 µs when TB = 0x90)							
The DID is supported							
2 CRC bytes							

The FSCI codes the FSC, which stands for the maximum frame size that the ST25TA64K is able to receive. The ST25TA64K is able to receive up to 256 bytes of command. If the RF host sends a command with more than 256 bytes, the ST25TA64K will not be able to treat the command and will not reply.

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

The SFGI codes the SFGT, which stands for the Start-up Frame Guard Time. This is the minimum time that the reader shall wait after receiving the response of the ST25TA64K.

5.9.3 PPS command and response

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 ST25TA64K) and descending (ST25TA64K to RF host) data rates.

Table 52. PPS command

	Name	INS		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							
	Ascending data rate							
-	2 CRC bytes							

The ascending and descending data rates shall be coded as described in *Table 53*.

Table 53. Ascending and descending data rate coding

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

When the ST25TA64K is able to change both data rates, it returns the response detailed in *Table 54*. The data rate of this response is 106 kbps; then, the ST25TA64K changes the ascending and descending data rates.

Table 54. PPS response

Name	INS	-	PPS0
Byte field	0xDX	-	0x11
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 ST25TA64K 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 ST25TA64K 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 procedures to access the memory or to manage its protection.

7.1 Selection of an NDEF message

The RF host shall use this procedure to detect the NDEF message inside an ST25TA64K.

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 that has been locked previously.

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Verify 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. Transmit 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 that has been locked previously.

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Verify 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 that has been locked previously.

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

7.7 Creating or updating an NDEF file

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Set the File Length to 0x00 using the UpdateBinary command
4. Write NDEF message content using the UpdateBinary command
5. Set the new File Length (must be always two written bytes), and elect the NDEF Tag Application

7.8 Changing the file type (applicable only on file 0x0001)

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 0x0001
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 ST25TA64K 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 55 describes the UID format.

Table 55. UID format

	0x02	0xC4	5 bytes
IC manufacturer code			
ST25TA64K product code			
Device number			

9 Maximum ratings

Stressing the device above the ratings listed in *Table 56* 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 56. Absolute maximum ratings

Symbol	Parameter		Min.	Max.	Unit
T_A	Ambient operating temperature		-40	85	°C
T_{STG}	Storage temperature	Sawn wafer on UV tape (kept in its original packing form)	15	25	°C
t_{STG}	Storage time		-	9 (1)	months
T_{STG}	Storage temperature	Sawn bumped wafer (kept in its antistatic bag)	15	25	°C
t_{STG}	Storage time		-	9 (2)	months
I_{CC} (3)	RF supply current AC0 - AC1		-	100	mA
V_{MAX_1} (3)	RF input voltage amplitude between AC0 and AC1, GND pad left floating	VAC0-VAC1	-	10	V
V_{MAX_2} (3)	AC voltage between AC0 and GND, or AC1 and GND	VAC0-GND or VAC1-GND	-0.5	4.5	V
V_{ESD}	Electrostatic discharge voltage (human body model) (4)	AC0-AC1	-	1000	V

1. Counted from ST shipment date.
2. Counted from ST production (taping) date.
3. Based on characterization, not tested in production. Maximum absorbed power = 100 mW at 7.5 A/m.
4. 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 57. Default operating conditions

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

Table 58. 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	1500	-	7500	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	-	-	6	-	ms
C_{TUN}	Internal tuning capacitor in SO8 (2)	f_C = 13.56 MHz	22.5	25	27.5	pF
t_{RF_OFF}	RF OFF time	Chip reset	-	-	5	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: 6
   Width of conductor: 0.6 mm
   Space between two conductors: 0.6 mm
   Value of the tuning capacitor in SO8: 25 pF (ST25TA64K)
   Value of the coil: 5 µH
   Tuning frequency: 14.2 MHz.
2. Characterized only, at room temperature only, measured at VAC0-VAC1 = 1 V peak to peak, at 13.56 MHz.

11 Ordering information

Table 59. Ordering information scheme for packaged devices

ST25 T A 64K - A B 6 G 3

Device type

ST25 = RF memory

Product Type

T = Tags + RFID

Protocol

A = ISO14443-A

Memory density

64K (binary)

Interface

A = None

Features

B = Basic features (no option)

Operating temperature

6 = -40 °C to +85 °C

Package / Packing

G = Bumped 120 µm

Capacitor value

3 = 25 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 60. Document revision history

Date	Revision	Changes
17-Apr-2015	1	Initial release.
01-Sep-2016	2	Updated *Description* and image on Cover page. Updated *Figure 2: Changing the read access right to an NDEF file* and *Figure 3: Changing the write access right to an NDEF file*. Added *Table 1: Signal names* and *Section 5.8.3: UpdateFileType command*. Updated *Section 5.9.2: RATS command and ATS response*, *Section 5.9.3: PPS command and response*, *Section 7.6: Reaching the read-only state for an NDEF file*, *Section 7.7: Creating or updating an NDEF file* and *Section 7.8: Changing the file type (applicable only on file 0x0001)*. Updated *Table 9: RF command sets*, *Table 10: I-Block format*, *Table 16: S-Block format*, *Table 41: C-APDU of the ExtendedReadBinary command* and *Table 59: Ordering information scheme for packaged devices*. Updated *Table 56: Absolute maximum ratings* and added footnote *2*. Updated title of *Table 50: Conversion from FSDI to FSD* and of *Section 11: Ordering information*.
20-Oct-2016	3	Updated *Section 3.4: NDEF file passwords*, *Section 5.9.1: Anticollision command set* and *Section 5.9.2: RATS command and ATS response*. Added *Table 4: CC file layout for one NDEF file* and *Table 48: Example of anticollision sequence*. Removed former footnote *1* from *Table 6: Field list*.
16-Feb-2017	4	Updated footnote *2* of *Table 58: RF characteristics*.