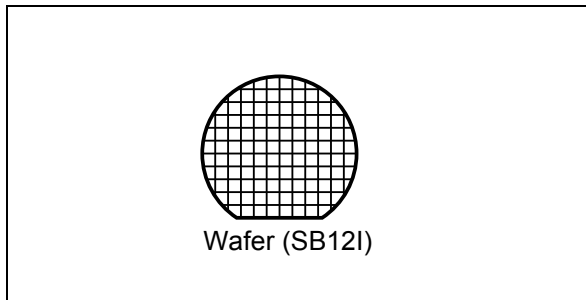


NFC Forum Type 4 Tag IC with 2-Kbit EEPROM

Datasheet - preliminary data

**Description**

The ST25TA02K 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 ST25TA02K 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

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 ST25TA02K 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 16
 - 3.3 Access right life time 16
 - 3.4 NDEF file passwords 16
 - 3.5 Read/Write counter 17
- 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 23
 - 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 | 25 |
| 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 | 40 |
| 6 | RF device operation | 42 |
| 6.1 | Anticollision and Device Activation command set for the RF interface | 42 |
| 6.2 | Open an RF session | 42 |
| 6.3 | Close an RF session | 42 |
| 6.4 | Applicative command set | 42 |
| 7 | Functional procedures | 43 |
| 7.1 | Selection of an NDEF message | 43 |
| 7.2 | Reading of an NDEF message | 43 |
| 7.3 | Reading a locked NDEF file | 43 |
| 7.4 | Locking an NDEF file | 43 |
| 7.5 | Unlocking an NDEF file | 44 |
| 7.6 | Reaching the read-only state for an NDEF file | 44 |
| 7.7 | Changing a File type Procedure | 44 |

| | | |
|----|--------------------------------|----|
| 8 | UID: Unique identifier | 45 |
| 9 | Maximum rating | 46 |
| 10 | RF electrical parameters | 47 |
| 11 | Part numbering | 48 |
| 12 | Revision history | 49 |

List of tables

| | | |
|-----------|--|----|
| Table 1. | Signal names | 8 |
| 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 | 23 |
| Table 17. | S-Block format | 24 |
| Table 18. | S-Block detailed format. | 24 |
| Table 19. | Command set overview | 25 |
| Table 20. | Status code of the ST25TA02K | 25 |
| Table 21. | Error code of the ST25TA02K | 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 | 39 |

| | | |
|-----------|--|----|
| Table 49. | Conversion from FDSI to FSD | 39 |
| Table 50. | ATS response | 40 |
| Table 51. | PPS command | 41 |
| Table 52. | Ascending and descending data rate coding | 41 |
| Table 53. | PPS response | 41 |
| Table 54. | UID format | 45 |
| Table 55. | Absolute maximum ratings | 46 |
| Table 56. | Default operating conditions | 47 |
| Table 57. | RF characteristics | 47 |
| Table 58. | Ordering information scheme for packaged devices | 48 |
| Table 59. | Document revision history | 49 |

List of figures

Figure 1. ST25TA02K 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 16

1 Functional description

The ST25TA02K 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 ST25TA02K is compatible with the NFC Forum Type 4 Tag specifications and supports all corresponding commands.

Figure 1 displays the block diagram of the ST25TA02K device.

Figure 1. ST25TA02K block diagram

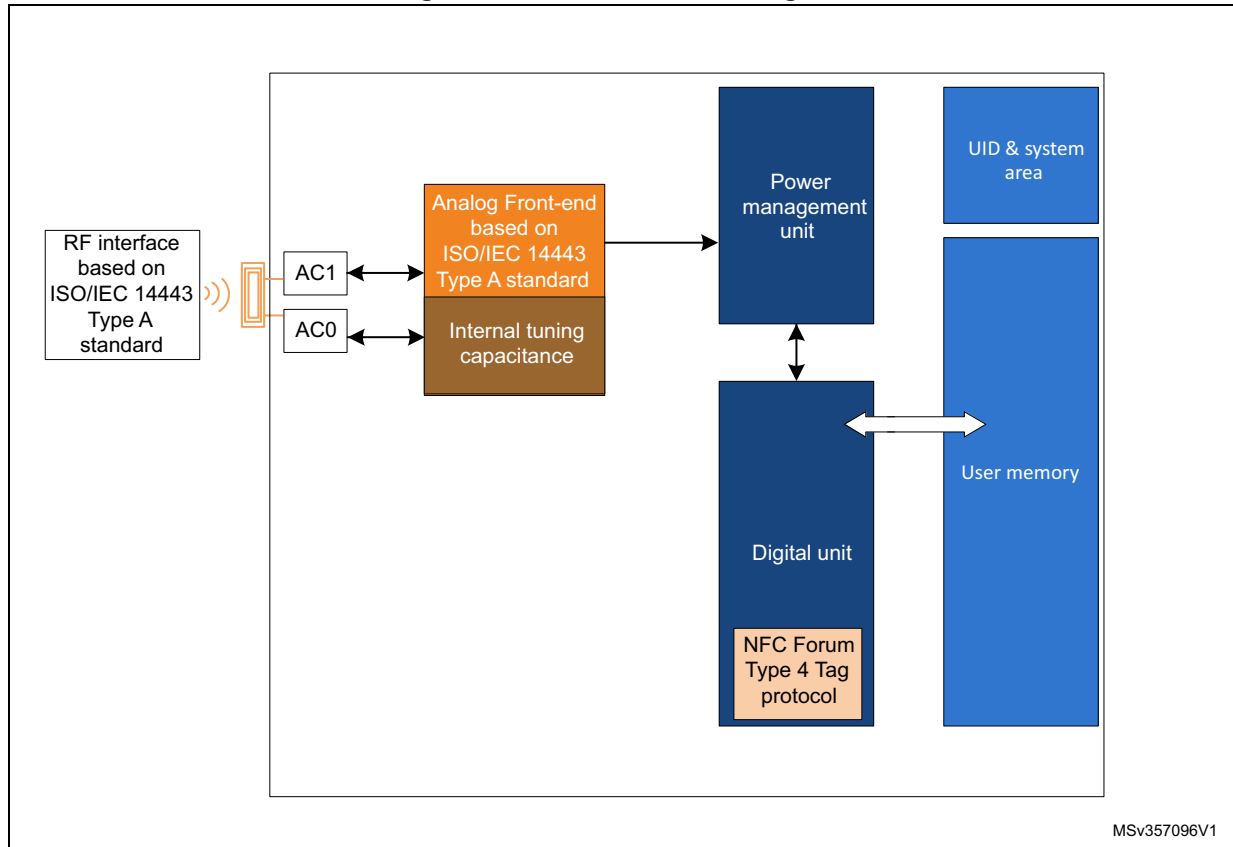


Table 1. Signal names

| Signal name | Function | Direction |
|-------------|---------------|-----------|
| AC0, AC1 | Antenna coils | - |

1.1 Functional mode

The ST25TA02K 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 ST25TA02K 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 ST25TA02K memory management

3.1 Memory structure

The ST25TA02K supports the NDEF Tag Application as defined in the NFC Forum Type 4 Tag. The ST25TA02K 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 ST25TA02K device. The CC file gives some information about the ST25TA02K 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 ST25TA02K 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 ST25TA02K 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 ST25TA02K device does not check if its value is relevant vs the data written by the RF host. The ST25TA02K device uses the NDEF Message Length, e. g. the standard read can be processed only inside the NDEF message; otherwise, the ST25TA02K 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 ST25TA02K. [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 | 0x13 ⁽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 ST25TA02K device before reading a read-locked NDEF file.

The write password shall be present on the ST25TA02K 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 |

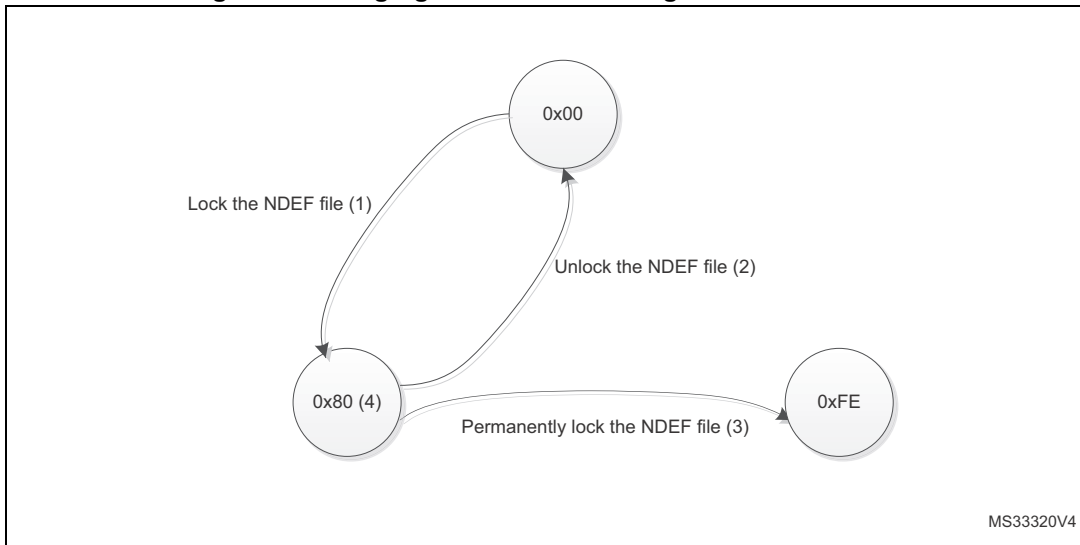
1. The write password shall be sent before writing in the NDEF file.

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

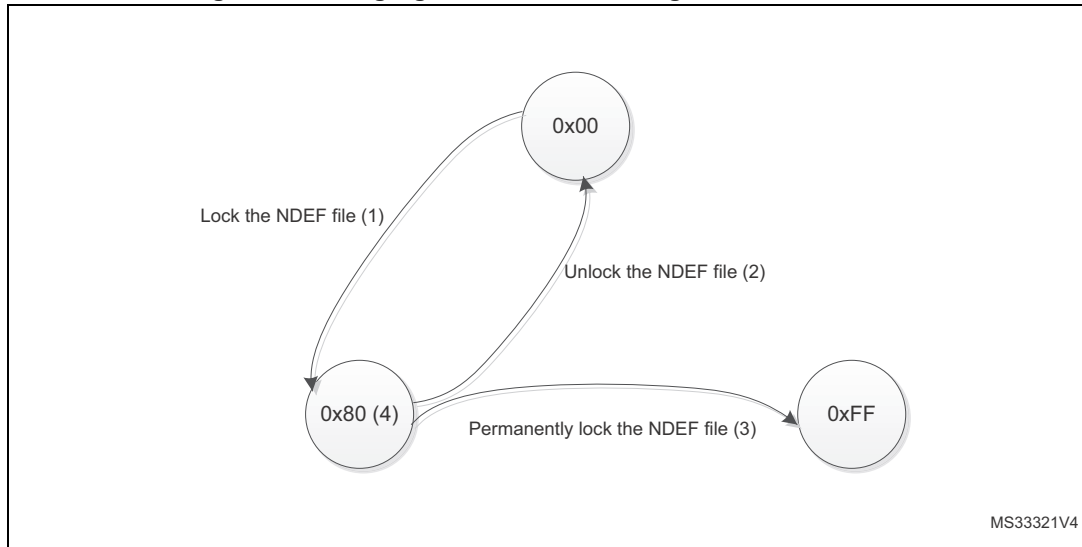


1. See the procedure to lock the read access ([Section 7.4: Locking an NDEF file](#)).
2. See the procedure to unlock the read access ([Section 7.5: Unlocking an NDEF file](#)).
3. See the procedure to permanently lock the read access ([Section 7.6: Reaching the read-only state for an NDEF file](#)).
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 ST25TA02K 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 ST25TA02K, 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: S-Block format](#)).

4 Communication mechanism

This section describes the principle of communication between an RF host and the ST25TA02K device.

4.1 Master and slave

The ST25TA02K 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 ST25TA02K 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 ST25TA02K 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 ST25TA02K. 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 ST25TA02K: C-APDU ST25TA02K 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 ST25TA02K.

ST25TA02K rules:

- Rule C. The ST25TA02K block number shall be initialized to 1 at activation.
- Rule D. When an I-block is received, the ST25TA02K shall toggle its block number before sending a block.

Note: *The ST25TA02K 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 ST25TA02K block number is received, the ST25TA02K 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 ST25TA02K the format of the payload is the C-APDU.

When the ST25TA02K 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 ST25TA02K. [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 ST25TA02K memory | | | | | | | |

1. See [Table 10](#)

5.2.2 R-APDU: payload format of a response

the ST25TA02K 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 ST25TA02K.

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 ST25TA02K
- 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 ST25TA02K 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 ST25TA02K enters the Standby power mode.

*In response to a RATS command, ST25TA02K returns FWI parameter (default frame waiting time used); when ST25TA02K 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 ST25TA02K 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 ST25TA02K. 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

ST25TA02K 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. |
| 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 ST25TA02K.

Table 20. Status code of the ST25TA02K

| | SW1 | SW2 | Comment |
|-------|------|------|--------------------------------|
| Value | 0x90 | 0x00 | Command completed successfully |

Table 21. Error code of the ST25TA02K

| | 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 ST25TA02K 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 $0x01 \leq Le \leq \max(\text{Selected File length}, 0xFFh)$ | | | | | | |

[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 ST25TA02K writes the data field into the selected file and sends back a status in the R-APDU response. If needed, ST25TA02K 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 ST25TA02K memory (empty field) | | | | | | |

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 is 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 ST25TA02K 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: 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 ST25TA02K 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 $0x01 \leq Le \leq 0xFF$ | | | | | | |

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, ST25TA02K in the Operating Field transmit the requested cascade level of their NFCID1 (NFCID1 CL_n, with n=1 or 2). The NFCID1 of ST25TA02K 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

| FDSI | 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 ST25TA02K.

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 ST25TA02K is able to receive. The ST25TA02K is able to receive up to 64 bytes of command. If the RF host sends a command with more than 64 bytes, the ST25TA02K 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 ST25TA02K.

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 ST25TA02K) and descending (ST25TA02K to RF host) data rates. Usage of this command is optional, ST25TA02K only supports 106 Kb/s in both direction.

b. Not useful in case of ST25TA02K which only support a Data Rate of 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 ST25TA02K is able to change both data rates, it returns the following response. The data rate of this response is 106 kbps; then, the ST25TA02K changes the ascending and descending data rates.

[Table 53](#) gives the details of the PPS response.

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 ST25TA02K 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 RF session

Once the RF host has terminated the anticollision procedure and retrieve the ATS response, it shall send the SelectApplication command. The ST25TA02K will open an RF session. At this point, the RF host can send the applicative command set.

6.3 Close an RF session

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 ST25TA02K.

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 ST25TA02K 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 | | | |
| ST25TA02K 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 | $T_A = 0^\circ\text{C}$ to 50°C | 1500 | - | 7500 | mA/m |
| $H_{Extended}$ | Operating field in extended temperature range | $T_A = -40^\circ\text{C}$ to 85°C | 100 | - | 7500 | mA/m |
| H_{min} | Field detect, Set-up field ⁽¹⁾ | $T_A = -40^\circ\text{C}$ 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 | - | $7 / f_C$ | - | t_1 | μs |
| t_3 | Pause A rise time | - | $1.5 \times t_4$ | - | $16 / f_C$ | 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⁾ | $f_C = 13.56 \text{ MHz}$ | 45 | 50 | 55 | pF |
| t_{RF_OFF} | RF OFF time | Chip reset | - | - | 0.1 | ms |

- 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 (ST25TA02K)
 Value of the coil: 2.5 μH
 Tuning frequency: 14.2 MHz.
- Time between command EOF and Response SOF when Updating NDEF message Length
- See [Capacitor value](#)
- Characterized only, at room temperature only, measured at $V_{AC0-VAC1} = 2 \text{ V}$ peak to peak at 13.56 MHz.

11 Part numbering

Table 58. Ordering information scheme for packaged devices

| | | | | | | | | | | |
|------------------------------|------|---|---|-----|---|---|---|---|---|---|
| Example: | ST25 | T | A | 02K | - | A | C | 6 | B | 5 |
| Device type | | | | | | | | | | |
| ST25 = RF memory | | | | | | | | | | |
| Product Type | | | | | | | | | | |
| T = Tags +RFID | | | | | | | | | | |
| Protocol | | | | | | | | | | |
| A = ISO14443-A | | | | | | | | | | |
| Memory density | | | | | | | | | | |
| 02K (binary) | | | | | | | | | | |
| Interface | | | | | | | | | | |
| A = None | | | | | | | | | | |
| Features | | | | | | | | | | |
| C = Counter as option | | | | | | | | | | |
| Operating temperature | | | | | | | | | | |
| 6 = -40°C to +85°C | | | | | | | | | | |
| Package / Packing | | | | | | | | | | |
| B = Bumped 120 μm | | | | | | | | | | |
| Capacitor value | | | | | | | | | | |
| 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 |
|-------------|----------|------------------|
| 05-May-2015 | 1 | Initial release. |

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST's terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers' products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2015 STMicroelectronics – All rights reserved