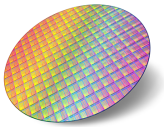
# ST25TA512B, ST25TA02KB
# ST25TA02KB-D, ST25TA02KB-P

Datasheet

NFC Forum Type 4 Tag IC with up to 2-Kbit EEPROM

UFDFPN5
(1.7x1.4mm)



Wafer

| Product status link |
|---|
| ST25TA512B |
| ST25TA02KB |
| ST25TA02KB-D |
| ST25TA02KB-P |

## Features

### Contactless interface

- NFC Forum Type 4 Tag, certified by the NFC Forum
- ISO/IEC 14443 Type A
- 106 kbps data rate
- Internal tuning capacitance: 50 pF

### Memory

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

### Product identification and protection

- TruST25™ digital signature

### Package

- UFDFPN5 ECOPACK®2

### Digital output

- GPO: configurable general purpose output
  - driven by an open drain transistor, available on ST25TA02KB-D only
  - enabling no DC consumption (CMOS output buffer), available on ST25TA02KB-P only.

## Description

The ST25TA512B and ST25TA02KB devices are NFC tag ICs, with an optional general purpose output available on ST25TA02KB-D and ST25TA02KB-P.

They embed an up to 2 -Kbit EEPROM, and can be operated from a 13.56 MHz RFID reader or an NFC phone.

The ST25TA512B, ST25TA02KB,

ST25TA02KB-D and ST25TA02KB-P devices are NFC Forum Type 4 Tags.

They communicate using the ISO/IEC 14443 Type A protocol, and feature a digital signature generated by TruST25™ (a set of software and procedures) used to prove the origin of the chip in cloning detection.

# 1 Functional description

The ST25TA512B, ST25TA02KB, ST25TA02KB-D and ST25TA02KB-P (hereinafter referred to as ST25TAxxxB) devices are NFC tags that can be accessed from the RF interface, based on the ISO/IEC 14443 Type A standard.

The ST25TAxxxB are compatible with the NFC Forum Type 4 Tag specifications and support all corresponding commands.

Figure 1, Figure 2 and Figure 3 show the block diagram, respectively, of the ST25TA02KB/ST25TA512B, ST25TA02KB-D and ST25TA02KB-P devices.

**Figure 1. Block diagram - ST25TA02KB and ST25TA512B**

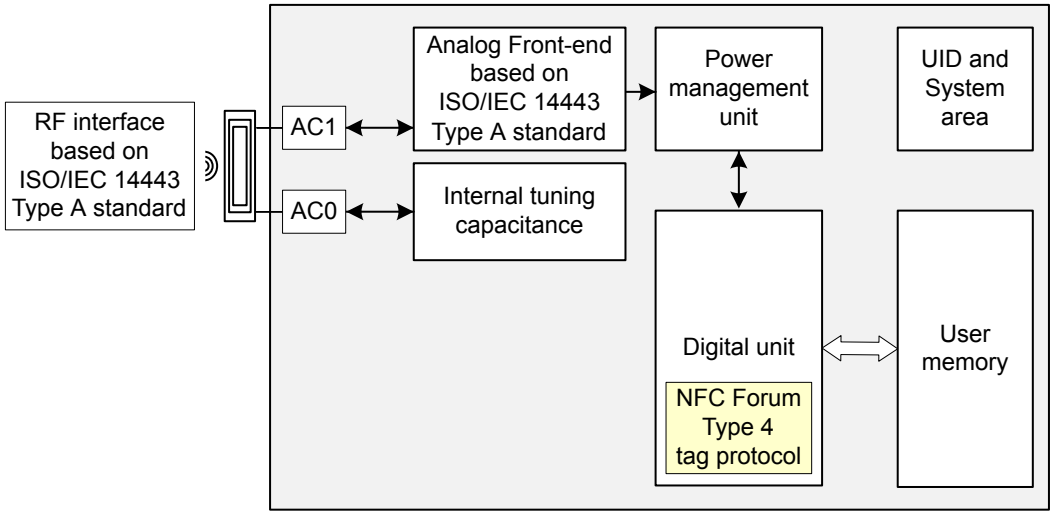



**Figure 2. Block diagram - ST25TA02KB-P**

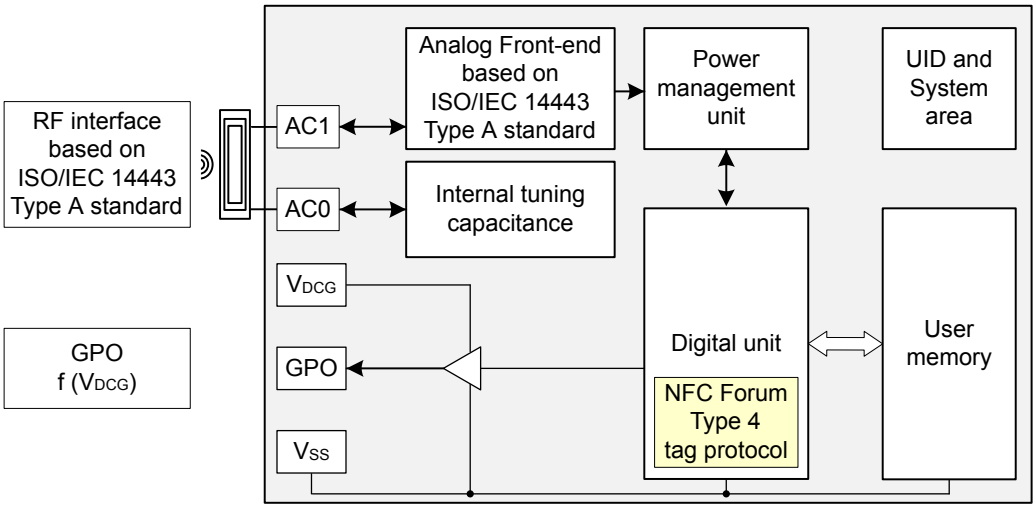


**Figure 3. Block diagram - ST25TA02KB-D**

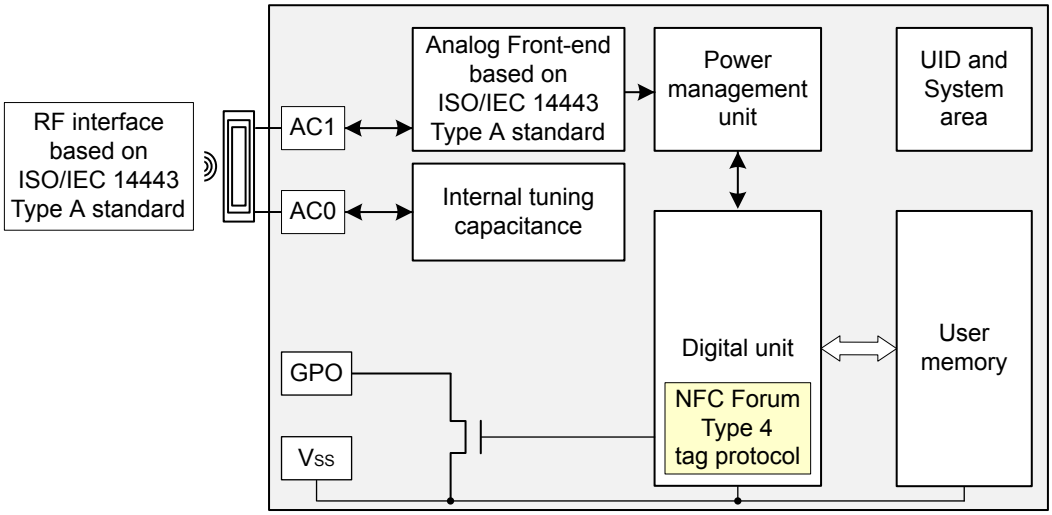
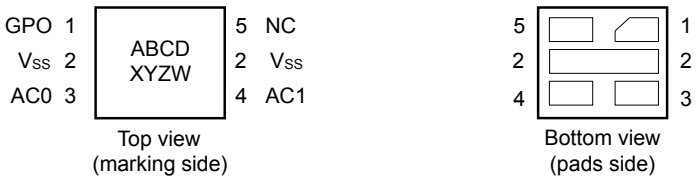



**Table 1. Signal names**

| Signal name | Function | Direction |
|---|---|---|
| AC0, AC1 | Antenna coils | - |
| $V_{DCG}$ (1) | Supply voltage for CMOS GPO driver | Power |
| $V_{SS}$ (2) | Ground | - |
| GPO(2) | Interrupt output | CMOS or Open drain output |

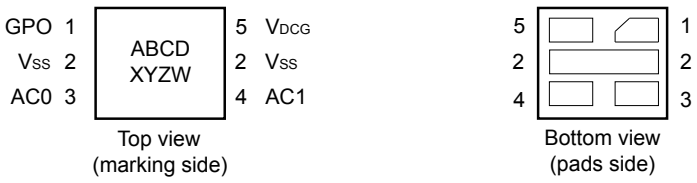
1. *Only available on ST25TA02KB-P.*
2. *Only available on ST25TA02KB-P and ST25TA02KB-D.*

**Figure 4. 5-pin package connections - ST25TA02KB-D**




1. See Section 13 Package information for package dimensions, and how to identify pin 1.

**Figure 5. 5-pin package connections - ST25TA02KB-P**




1. See Section 13 Package information for package dimensions, and how to identify pin 1.

## 1.1 Functional mode

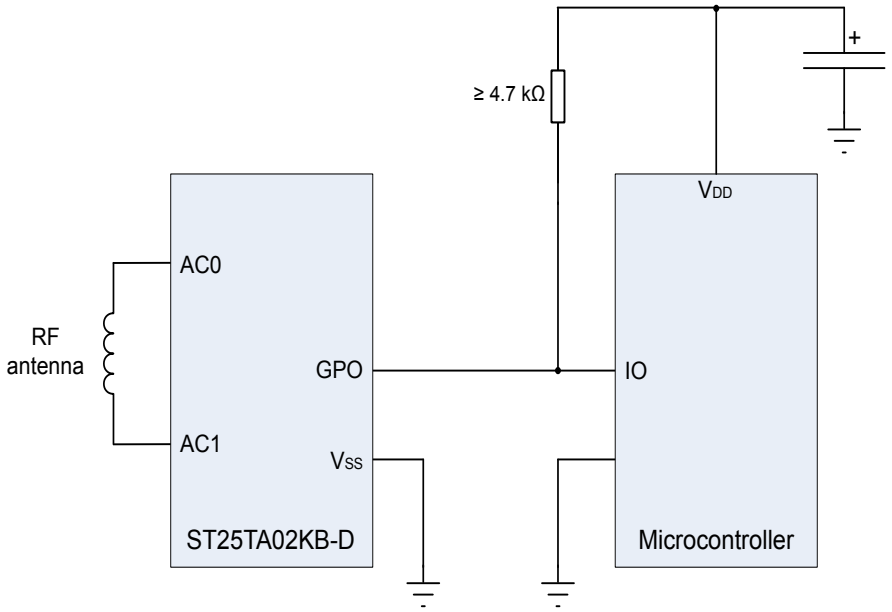
The ST25TAxxxB have only one functional mode available (see Table 2).

**Table 2. Functional mode**

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

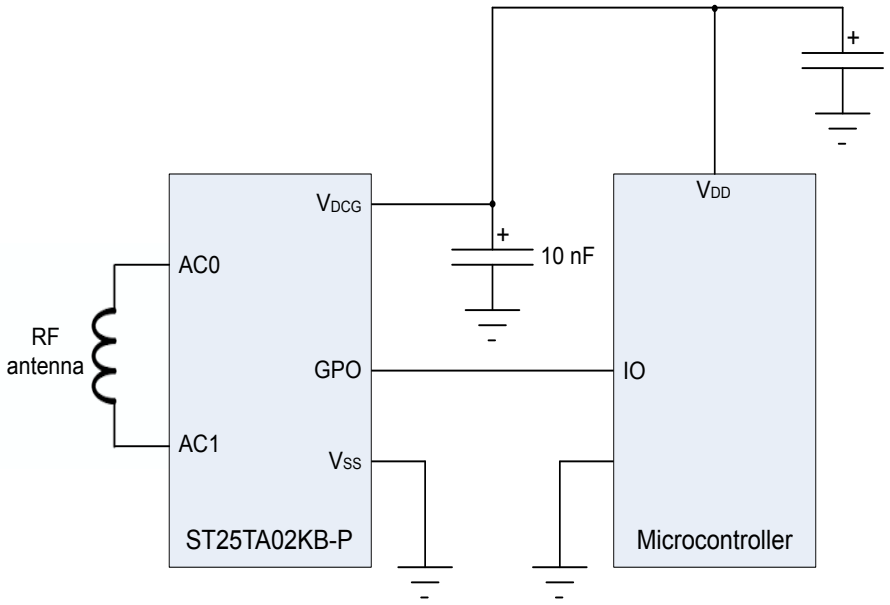
The optional GPO open drain transistor requests an external pull-up (> 4.7 KΩ) to operate (see Figure 6).

**Figure 6. Applicative example of GPO usage - ST25TA02KB-D**




The optional GPO CMOS driver requests an external supply to operate (see Figure 7).

**Figure 7. Applicative example of GPO usage - ST25TA02KB-P**




### 1.1.1 Tag mode

The ST25TAxxxB are supplied by the RF field and can communicate with an RF host (RFID reader or NFC phone). The User memory can be accessed by the RF commands.

# 2 Signal description

## 2.1 Antenna coil (AC0, AC1)

These inputs are used to connect the ST25TAxxxB devices to an external coil exclusively. It is advised not to connect any other DC or AC path to neither AC0 nor AC1.

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

## 2.2 Ground ($V_{SS}$), only available on ST25TA02KB-P and ST25TA02KB-D

$V_{SS}$, when connected, is the reference for the $V_{DCG}$ supply voltage and for all pads, including AC0 and AC1.

## 2.3 GPO supply voltage ($V_{DCG}$), only available on ST25TA02KB-P

This pin can be connected to an external DC supply voltage. It only supplies the GPO driver block.

### 2.3.1 Operating supply voltage $V_{DCG}$

Before checking ST25TA02KB-P GPO, a valid and stable $V_{DCG}$ voltage within the specified [$V_{DCG(min)}$, $V_{DCG(max)}$] range must be applied.

To maintain a stable DC supply voltage, it is recommended to decouple the $V_{DCG}$ line with suitable capacitors (usually of the order of 10 nF and 100 pF) close to the $V_{DCG}$ / $V_{SS}$ package pins.

This voltage must remain stable and valid until the end of the GPO usage by the ST25TA02KB-P.

### 2.3.2 Power-up conditions

The $V_{DCG}$ rise time must not vary faster than 1 V / µs.

## 2.4 General purpose output (GPO), only available on ST25TA02KB-P and ST25TA02KB-D

The GPO pad is either an open drain pad on which an external pull-up resistor shall be connected, or a CMOS pad with default polarity set to 0.

This pad is a configurable output signal, driven to active level when configured events occur. Its behavior is consistent with the RF session activated and with the mode chosen by the user, see Section 7 Functional procedures for more details.

# 3 ST25TAxxxB memory management

## 3.1 Memory structure

The ST25TAxxxB support the NDEF Tag Application as defined in the NFC Forum Type 4 Tag. They are composed of three files:

- a Capability Container (CC) file
- an NDEF file
- a System file: this file is an ST-proprietary file

The System file contains some information on the configuration of the ST25TAxxxB devices. The CC file gives some information about the ST25TAxxxB 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 ST25TAxxxB 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**

| 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 | MLe: Maximum number of bytes that can be read | 0x00FF (2) | 255 bytes(2) |
| | | 0x0040 (3) | 64 bytes(3) |
| 0x0005 | MLc: Maximum number of bytes that can be written | 0x0036 | 54 bytes |
| 0x0007 | NDEF file control TLV | 0x04 (4) | T field |
| 0x0008 | | 0x06 | L field |
| 0x0009 | | 0x0001 | FileID |
| 0x000B | | 0x0100(2) | FLEN: Maximum NDEF file size in Bytes |
| | | 0x0040(3) | |
| 0x000D | | 0x00(4) | CCRD: Read access condition |
| 0x000E | | 0x00(4) | CCWR: Write access condition |

1. *According to the reader command format the ST25TAxxxB devices will automatically align to the corresponding NFC Forum version.*
2. *ST25TA02KB, ST25TA02KB-D and ST25TA02KB-P.*

3. *ST25TA512B.*
4. *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 ST25TAxxxB devices do not check if its value is relevant vs. the data written by the RF host. If the NDEF Message Length value stored in the file is greater than FLEN-2 (NDEF Message Length > FLEN-2 can occur because of a successful UpdateBinary command with wrong value, or because of a corrupted UpdateBinary command.) the tag handles it as an invalid case and returns 0x00 for the byte values at offsets 0x0000 and 0x0001 in the response to a ReadBinary command.

For more details about the read command, refer to Section 6.7.5 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(1) or 0x003C (2) | ... | ... | ... | User data |

1. *ST25TA02KB, ST25TA02KB-D and ST25TA02KB-P.*
2. *ST25TA512B.*

### 3.1.4 System file layout

The system file specifies the configuration of the ST25TAxxxB devices. Table 6 lists the different fields.

**Table 6. Field list**

| File offset | Field name | No. of bytes | Read access | Write access | Device(s) | Delivery state |
|---|---|---|---|---|---|---|
| 0x0000 | Length system file | 2 | Yes | - | ST25TA512B<br>ST25TA02KB<br>ST25TA02KB-D<br>ST25TA02KB-P | 0x0012 |
| 0x0002 | ST reserved | 1 | Yes | None | ST25TA512B<br>ST25TA02KB | 0x80 |
| | GPO Config | | | Yes (1) | ST25TA02KB-D<br>ST25TA02KB-P | 0x70 (2) |
| 0x0003 | Event Counter Config | 1 | Yes | Yes(1) | ST25TA512B | 0x00 |
| 0x0004 | 20-bit counter<br>(MS nibble 0x0) | 3 | Yes | None | ST25TA02KB<br>ST25TA02KB-D | 0x000000 |
| 0x0007 | Product version | 1 | Yes | None | ST25TA02KB-P | 0x22 (3) |
| 0x0008 | UID | 7 | Yes | None | ST25TA512B | 0x02E4 xx xx xx xx xx (4) |
| | | | | | ST25TA02KB | 0x02E3 xx xx xx xx xx(4) |
| | | | | | ST25TA02KB-D | 0x02F3 xx xx xx xx xx(4) |
| | | | | | ST25TA02KB-P | 0x02A3 xx xx xx xx xx(4) |
| 0x000F | Memory Size - 1 | 2 | Yes | None | ST25TA512B | 0x003F |
| | | | | | ST25TA02KB<br>ST25TA02KB-D<br>ST25TA02KB-P | 0x00FF |
| 0x0011 | IC reference code | 1 | Yes | None | ST25TA512B | 0xE5 |
| | | | | | ST25TA02KB | 0xE2 |
| | | | | | ST25TA02KB-D | 0xF2 |
| | | | | | ST25TA02KB-P | 0xA2 |

1. *Configuration bytes can be locked by setting the Most significant bit to 1. Once locked, these bytes cannot be changed anymore.*
2. *Field detect as GPO configuration.*
3. *ST reserved.*
4. *x values are defined by ST to ensure UID uniqueness.*

**Table 7. Details about the Counter configuration field**

| File offset | b7 | b6-b2 | b1 | b0 |
|---|---|---|---|---|
| 0x0003 | | | | |
| Counter configuration lock bit:<br>• 0b0: unlocked<br>• 0b1: locked | | | | |
| 0b00000 (ST reserved) | | | | |
| Counter enable:<br>• 0b0: disable<br>• 0b1: enable | | | | |
| Counter increment:<br>• 0b0: on Read<br>• 0b1: on Write | | | | |

**Table 8. Details about the GPO field**

| File offset | b7 | b6-b4 | b3-b0 |
|---|---|---|---|
| 0x0002 | | | |
| GPO configuration lock bit:<br>• 0b0: unlocked<br>• 0b1: locked | | | |
| GPO configuration:<br>• 0b000: Not used<br>• 0b001: Session opened<br>• 0b010: WIP<br>• 0b011: MIP<br>• 0b100: Interrupt<br>• 0b101: State Control<br>• 0b110: RF Busy<br>• 0b111: Field Detect | | | |
| 0b0000<br>(ST reserved) | | | |

## 3.2 Read and write access rights to the NDEF file

The NDEF file can be protected for read or write accesses with passwords 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 also be locked for read or write accesses. Thus, the host cannot access the NDEF file.

The read password shall be sent to the ST25TAxxxB devices before reading a

read-protected NDEF file.

The write password shall be sent to the ST25TAxxxB devices before writing a

write-protected NDEF file. The write password shall be sent to change the read or write protection mode. The access rights are only relevant for the NDEF file. If the Verify command is used with the CC, System or no file selected, an error is responded by the tag.

### 3.2.1 Read and Write protection modes

Three protection modes are defined for each of the Read and Write access rights to the NDEF file:

- UNPROTECTED
- PROTECTED
- FORBIDDEN

The Read/Write protection mode is identified by the R-APDU value responded to a Verify command (see Section 6.8.1 Verify command).

**Table 9. Read protection modes**

| Mode | Verify (P1P2=0x0001) R-APDU | Meaning |
|---|---|---|
| READ UNPROTECTED | 0x9000 | Read access without any security (delivery state) |
| READ PROTECTED | 0x6300 | Read access protected by password |
| READ FORBIDDEN | 0x6984 | Read access forbidden (permanent state) |

**Table 10. Write protection modes**

| Mode | Verify (P1P2=0x0002) R-APDU | Meaning |
|---|---|---|
| WRITE UNPROTECTED | 0x9000 | Write access without any security (delivery state) |
| WRITE PROTECTED | 0x6300 | Write access protected by password |
| WRITE FORBIDDEN | 0x6984 | Write access forbidden (permanent state) |

### 3.2.2 Read and Write access conditions

The CCRD and CCWR bytes (see Table 3. File identifier) in the CC file are used to identify the Read and Write access conditions for the NDEF message as defined in the NFC Forum Type 4 Tag specification. The ST25TAxxxB support one read condition value and two write condition values.

Table 11 and Table 12 show how these condition values are mapped to the read and write protection modes defined in Section 3.2.1 Read and Write protection modes.

**Caution:** As several protection modes may be mapped to a single condition value, the Read and Write access condition values are not to be used to identify the protection modes.

**Table 11. Read access conditions (CCRD values)**

| Value | Read protection modes |
|---|---|
| 0x00 | UNPROTECTED, PROTECTED, FORBIDDEN (1) |

1. *Refer to Section 3.2.1 Read and Write protection modes to discriminate between the protection modes.*

**Table 12. Write access conditions (CCWR values)**

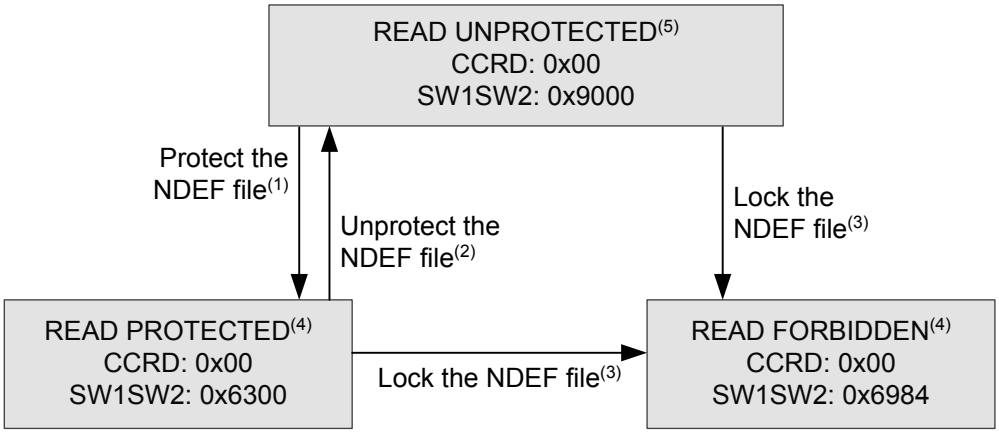
| Value | Write protection modes |
|---|---|
| 0x00 | UNPROTECTED |
| 0xFF | PROTECTED, FORBIDDEN(1) |

1. *Refer to Section 3.2.1 Read and Write protection modes to discriminate between the protection modes.*

### 3.2.3 Changing the read protection mode

The state diagram of Figure 8 shows how to change the read protection mode of the NDEF file.

**Figure 8. Changing the read protection mode**



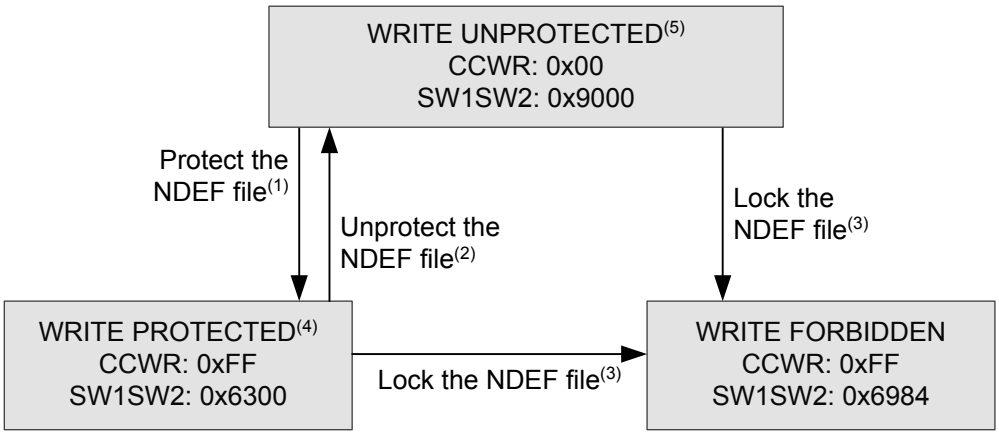

CCRD: byte at offset 0x000D in the CC file
SW1SW2: response to the Verify (Read protection) command

1. See the procedure to protect the read access (Section 7.1 Protecting an NDEF file).
2. See the procedure to unprotect the read access (Section 7.3 Unprotecting an NDEF file).
3. See the procedure to forbid the read access (Section 7.4 Locking an NDEF file).
4. Proprietary state, not defined by NFC Forum Type 4 Tag.
5. Delivery state.

### 3.2.4 Changing the write protection mode

The state diagram of Figure 9 shows how to change the write protection mode of the NDEF file.

**Figure 9. Changing the write protection mode**




CCWR: byte at offset 0x000E in the CC file
SW1SW2: response to the Verify (Write protection) command

1. See the procedure to protect the write access (Section 7.1 Protecting an NDEF file).
2. See the procedure to unprotect the write access (Section 7.3 Unprotecting an NDEF file).

3. See the procedure to forbid the write access (Section 7.4 Locking an NDEF file).
4. Proprietary state, not defined by NFC Forum Type 4 Tag.
5. Delivery state.

## 3.3 Granted access life time

When the NDEF file is in a READ or WRITE PROTECTED state, the corresponding file access is granted starting from the first successful password presentation (see Section 7.1 Protecting an NDEF file), and until one of the following events occurs:

- an RF field shutdown
- a successful DESELECT command
- a successful NDEF Tag Application Select command (no file selected)
- successful Capability Container Select or System File Select command (other file selected)
- a wrong password presentation (security session closed)

When the NDEF file is in a READ or WRITE FORBIDDEN state, the corresponding file access is never granted.

## 3.4 NDEF file passwords

Two passwords are available on the ST25TAxxxB devices:

- Read password: protects the read access to the NDEF file
- Write password: protect the write access to the NDEF file and the setting of the read and write protection modes (see Section 7.1 Protecting an NDEF file and Section 7.2 Accessing a protected NDEF file)

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

A password is presented using the Verify command (see Section 6.8.1 Verify command).

After three consecutive authentication failures for a given password, further attempts will fail until the following sequence of events occurs:

- tag set in Standby power mode (RF field shutdown or DESELECT command)
- tag activation (anticollision and RATS commands)
- successful NDEF Tag Application Select command
- successful NDEF Select command

*Note: The delivery state for all passwords is 0x00000000000000000000000000000000.*

# 4 Specific features

## 4.1 Read/Write counter

A 20-bit 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 System file layout).

If enabled, the Read/Write counter will be incremented on the first event (exclusively read / write) performed on the NDEF File, after a successful NDEF Tag Application Select command. Following read/write events will not modify the counter value until a new successful NDEF Tag Application Select command is issued.

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 System file layout).

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

**Caution:** 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 being countered: the counter increment needs some write cycles of specific EEPROM cells automatically managed by ST25TAxxxB, this increases 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 6.4 S-Block format).

## 4.2 General purpose output (GPO), only available on ST25TA02KB-D/P

The GPO pad is either a CMOS pad (ST25TA02KB-P) or an open drain pad (ST25TA02KB-D).

In case of CMOS GPO active state is 1 and inactive state is 0.

In case of open drain an external pull-up shall be connected to it. In this case, active state is 0 and inactive state is 1. If no pull-up is used the active state is 0, but inactive state is HZ.

This pad is a configurable output signal, driven to the alternate polarity when configured event occur. Its behavior is consistent with the RF session activated and with the mode chosen by the user.

The user can select one of these configurations (Table 68. GPO timings measurement ):

- Inactive: the state of the GPO pad is always inactive
- SessionOpen: an RF session is ongoing.
- MIP (NDEF Message updating In Progress): the RF host is writing an NDEF length different from 0x0000. This mode can be used to detect when the RF host changes the NDEF message as defined by the NFC Forum.
- WIP (Writing In Progress): the ST25TA02KB-D/P is executing a writing operation.
- INT (interrupt): the RF host can force the ST25TA02KB-D/P to send an alternate pulse on the GPO pin.
- State mode: the RF host can control the state of the GPO pad during the RF session.
- RF busy: an RF host is communicating with the ST25TA02KB-D/P.
- Field detection: the RF field is sufficient to establish an RF communication with the ST25TA02KB-D/P.

GPO configuration byte can be locked, by setting its Most Significant Bit to 1 (1xxx 0000 b). Once locked, this byte cannot be changed anymore.

### 4.2.1 Inactive configuration (GPO field = 0x00 or 0x80)

When the GPO is configured as "Inactive", it remains in inactive state regardless of the events on the RF interface (except setting the GPO to another configuration).

### 4.2.2 Session Open configuration (GPO field = 0x10 or 0x90)

When the GPO is configured as “Session Open”, it goes to the active state when an RF session is ongoing (see Figure 10 or Figure 11).

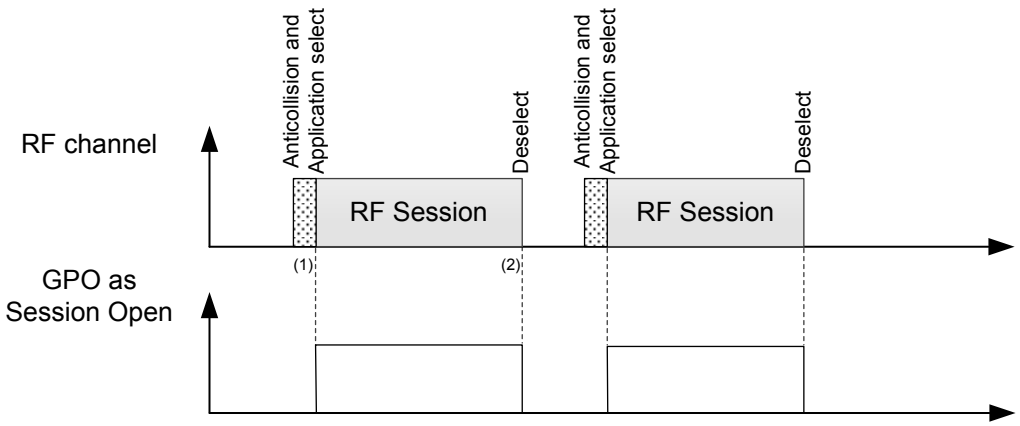
An RF session is taken when the ST25TA02KB-D/P receives a valid Select Application. The session is released when:

- ST25TA02KB-D/P receives a valid Deselect command
- RF field becomes OFF

GPO is driven to active state after a delay (1.) when the session is open.

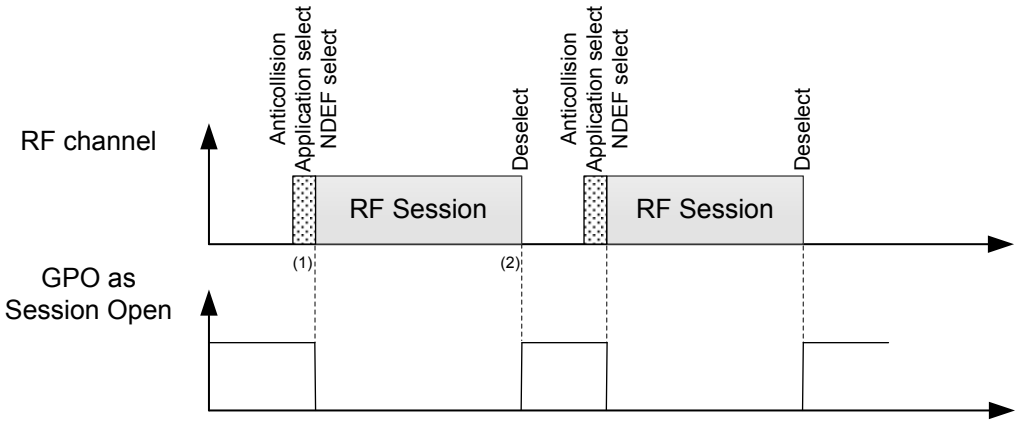
GPO is released after a delay (2.) when the session is released.

**Figure 10. CMOS GPO configured as Session Open (GPO field = 0x10 or 0x90)**




1. CmdEOFtoGPhigh (RF command End of frame to GPORF Session pad high).
2. CmdEOFtoGPlow (RF command End of frame to GPORF Session pad low).

**Figure 11. Open drain GPO configured as Session Open (GPO field = 0x10 or 0x90)**




1. CmdEOFtoGPlow (RF command End of frame to GPORF Session pad low).
2. CmdEOFtoGPHZ (RF command End of frame to GPORF Session pad HZ).

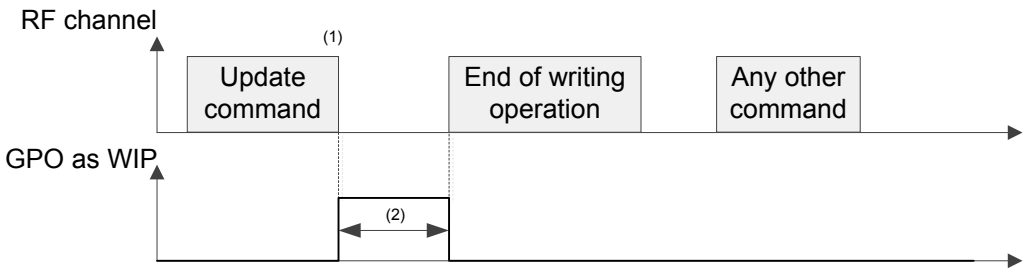
### 4.2.3 WIP Writing in Progress configuration (GPO field = 0x20 or 0xA0)

When the GPO is configured as “WIP”, it goes to the active state state during an RF writing operation (see Figure 12 or Figure 13).

During an RF session, when the ST25TA02KB-D/P updates a file, the GPO is driven in active state after a delay (1.) following the beginning of the correspondent UpdateBinary command execution.

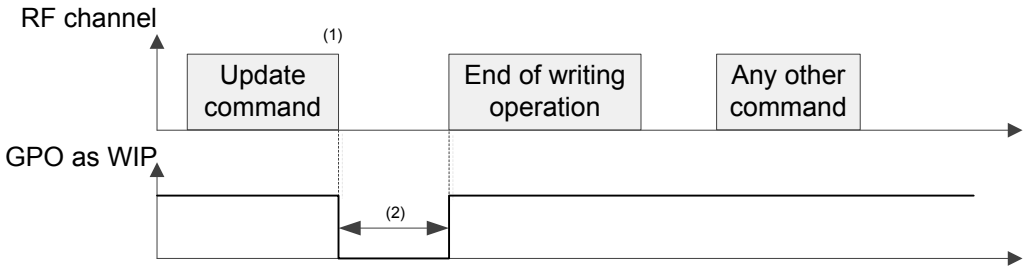
GPO will remain in active state during the writing time (2.), before being released.

**Figure 12. CMOS GPO configured as WIP (GPO field = 0x20 or 0xA0)**




1. CmdEOFtoGPhigh (RF Command End of frame to GPO high).
2. Writing time duration.

**Figure 13. Open drain GPO configured as WIP (GPO field = 0x20 or 0xA0)**




1. CmdEOFtoGPlow (RF Command End of frame to GPO low).
2. Writing time duration.

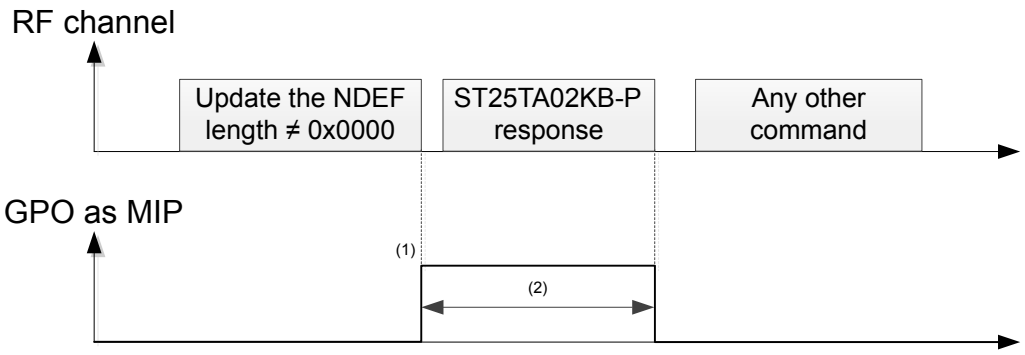
### 4.2.4 MIP NDEF Message writing in Progress configuration (GPO field = 0x30 or 0xB0)

When the GPO is configured as MIP, its state goes to the active state when the RF host writes the NDEF length to another value than 0x0000 (see Figure 14 or Figure 15).

During an RF session, when the ST25TA02KB-D/P changes an NDEF file and updates the NDEF length with a value different from 0x0000, the GPO is driven in active state after a delay (1.) following the beginning of the correspondent UpdateBinary command execution.

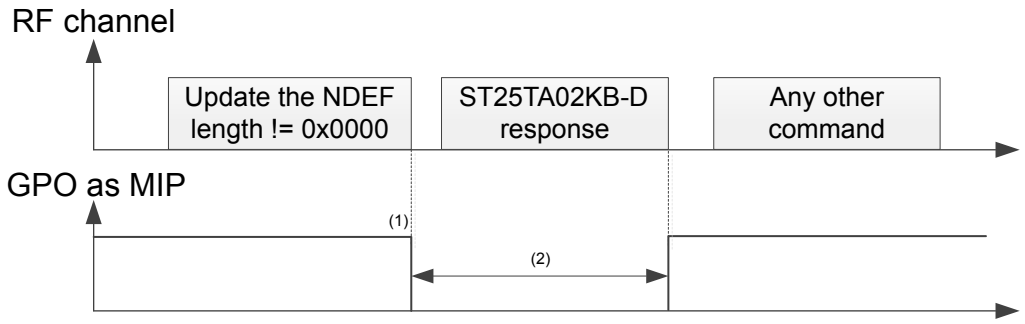
GPO will remain in active state during the writing time (2.), before being released.

**Figure 14. CMOS GPO configured as MIP (GPO field = 0x30 or 0xB0)**




1. CmdEOFtoGPhigh (RF command End of frame to GPO high).
2. Writing time duration.

**Figure 15. Open drain GPO configured as MIP (GPO field = 0x30 or 0xB0)**



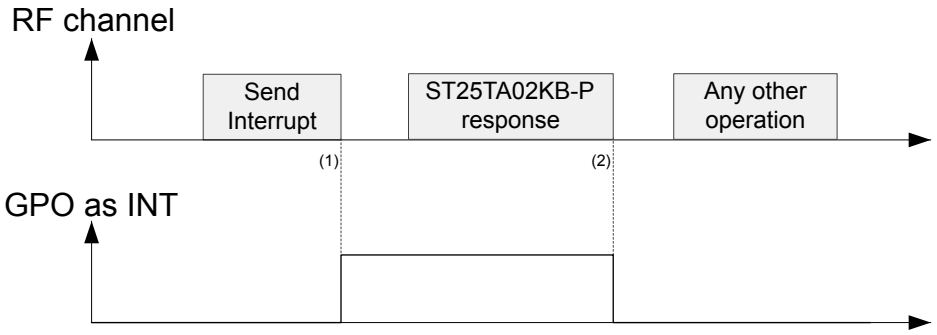

1. CmdEOFtoGPlow (RF command End of frame to GPO low).
2. Writing time duration.

### 4.2.5 INT Interrupt configuration (GPO field = 0x40 or 0xC0)

The RF host can send a pulse on the GPO pad. The GPO pad goes to active state at the end of the command and goes to the inactive state at the end of the ST25TA02KB-D/P response (see Figure 16 or Figure 17).

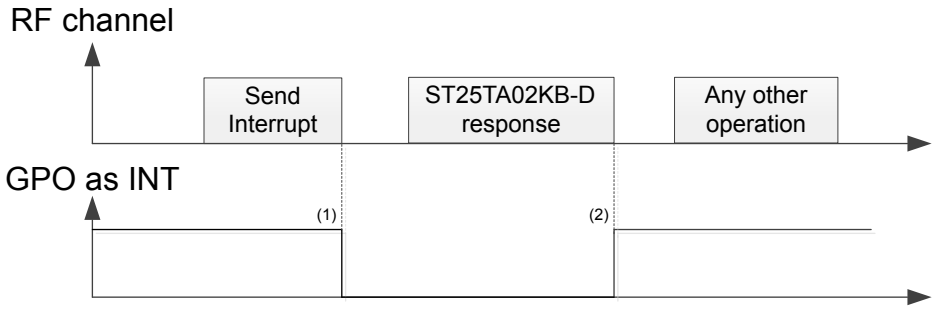
During an RF session, when the ST25TA02KB-D/P receives a valid SendInterrupt command, the GPO pin is driven in active state (1.). Then the GPO pin is released at the end of the response (2.).

**Figure 16. CMOS GPO configured as INT (GPO field = 0x40 or 0xC0)**




1. CmdEOFtoGPhigh (RF command End of frame to GPO high).
2. RespEOFtoGPlow.

**Figure 17. Open drain GPO configured as INT (GPO field = 0x40 or 0xC0)**

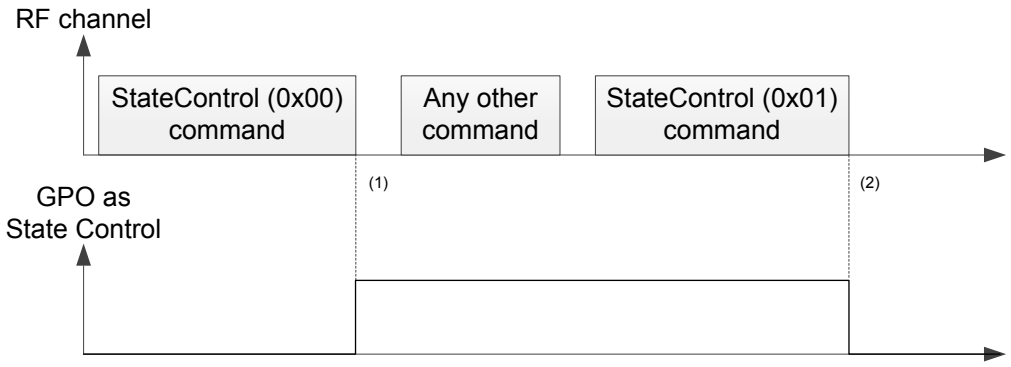


### 4.2.6 State Control configuration (GPO field = 0x50 or 0xD0)

When the GPO is configured as State Control, the RF host can control the state of the GPO by sending a dedicated command (see Figure 18 or Figure 19).

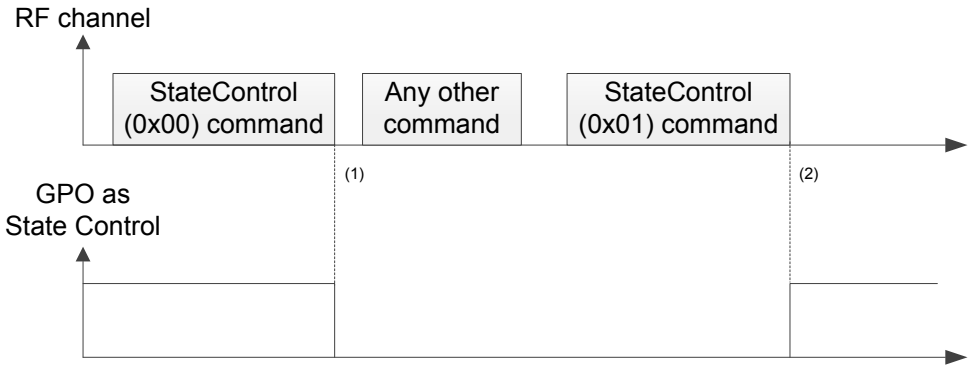
During an RF session, the ST25TA02KB-D/P can control the GPO pin. After receiving a valid StateControl command with Data=0x00, the GPO pin is driven in active state after a delay (1.). The GPO will be released after a valid StateControl command with Data=0x01 or after a Power off.

**Figure 18. CMOS GPO configured as State Control (GPO field = 0x50 or 0xD0)**




1. CmdEOFtoGPhigh (RF Reset GPO command End of frame to GPO high).
2. CmdEOFtoGPlow (RF Set GPO command End of frame to GPO low).

**Figure 19. Open drain GPO configured as State Control (GPO field = 0x50 or 0xD0)**



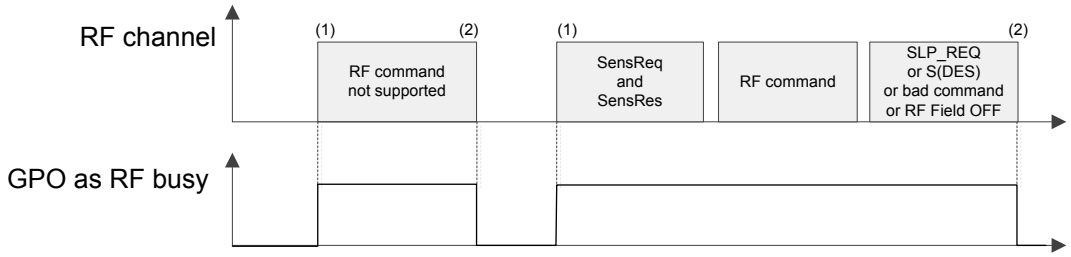

1. CmdEOFtoGPlow (RF Reset GPO command End of frame to GPO low).
2. CmdEOFtoGPHZ (RF Set GPO command End of frame to GPO HZ).

### 4.2.7 RF busy configuration (GPO field = 0x60 or 0xE0)

When the GPO is configured as RF busy, the GPO goes to the active state, both when the ST25TA02KB-D/P is processing an RF command or when an RF session is ongoing (see Figure 20 or Figure 21).

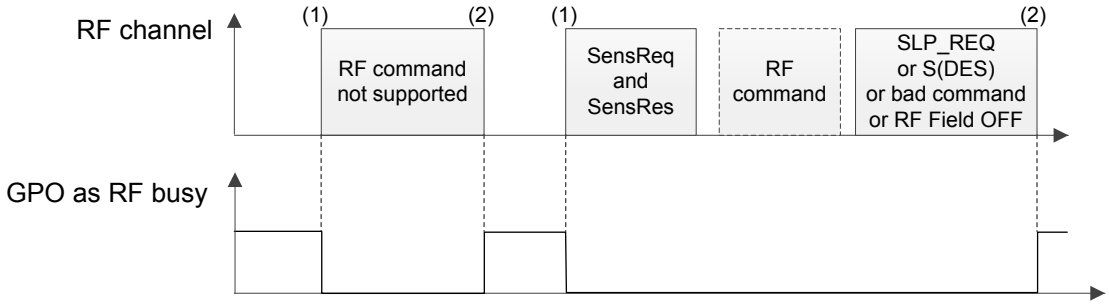
When an RF field is present, the GPO is driven in active state after a delay (1.) when the ST25TA02KB-D/P detects the first command. If the RF session is ongoing and the ST25TA02KB-D/P receives a not-supported command, GPO remains active. It will be released only at the end of the RF session, after (2.).

**Figure 20. CMOS GPO configured as RF busy (GPO field = 0x60 or 0xE0)**




1. CmdSOFtoGPhigh (RF command Start of frame to GPO high).
2. CmdEOFtoGPlow (RF command End of frame to GPO low).

**Figure 21. Open drain GPO configured as RF busy (GPO field = 0x60 or 0xE0)**




1. CmdSOFtoGPlow (RF command Start of frame to GPO low).
2. CmdEOFtoGPHZ (RF command End of frame to GPO HZ).

### 4.2.8 Field detect configuration (GPO field = 0x70 or 0xF0)

When the GPO is configured as Field detect, the GPO goes to the active state when ST25TA02KB-D/P detects an RF Field (see Figure 22 or Figure 23).

When an RF field is present, GPO is driven in active state after a delay when the ST25TA02KB-D/P detects this field. Whatever the activity during the RF field detection (communication with the reader or not), GPO will stay active. It will be released when the ST25TA02KB-D/P leaves the RF field.

**Figure 22. CMOS GPO configured as Field detect (GPO field = 0x70 or 0xF0)**

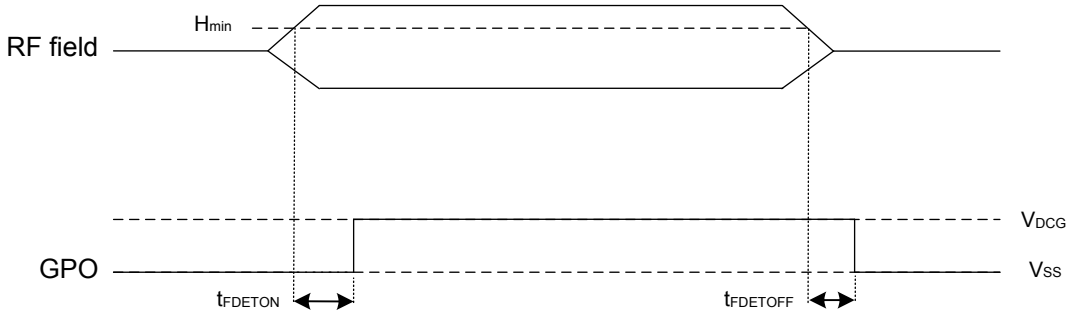
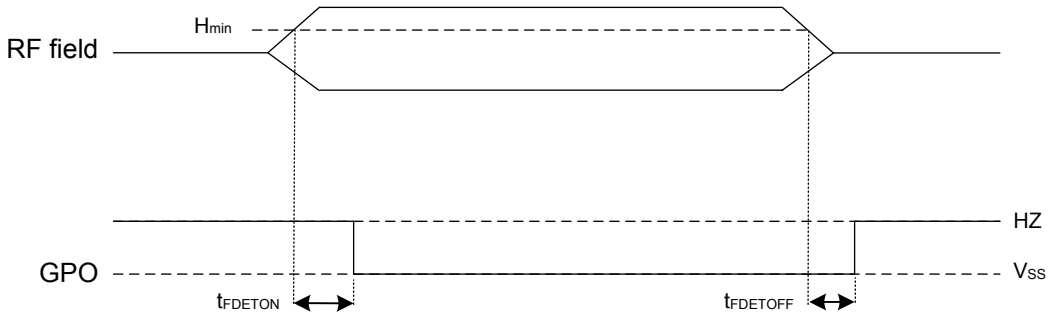



**Figure 23. Open drain GPO configured as Field detect (GPO field = 0x70 or 0xF0)**




## 4.3 TruST25™ digital signature feature

The ST25TAxxxB devices support the TruST25™ digital signature feature, which allows the user to verify the authenticity of the device, based on a unique digital signature.

TruST25™ solution encompasses secure industrialization processes and tools deployed by STMicroelectronics to generate, store and check the signature in the device.

Implementation details are described in application note AN5101, contact your STMicroelectronics sales office to get this document.

# 5 Communication mechanism

This section describes the principle of communication between an RF host and the ST25TAxxxB devices.

## 5.1 Master and slave

The ST25TAxxxB act as slave devices on the RF channel and therefore wait for a command from the RF host before sending a response.

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

# 6 RF command sets

This section describes the ST25TAxxxB 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 ST-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 6.2 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 Section 6.3 R-Block format and to Section 6.4 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 13 lists the RF command sets.

**Table 13. 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 an NDEF file |
| ISO/IEC 7816-4 | Verify | 0x00 | 0x20 | Checks the right access of an 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 |
| ST-proprietary | EnablePermanentState | 0xA2 | 0x28 | Enables the READ FORBIDDEN or the WRITE FORBIDDEN protection mode |
| | ExtendedReadBinary | 0xA2 | 0xB0 | Reads data from file |
| | UpdateFileType | 0xA2 | 0xD6 | Sets file type to NDEF or to proprietary |
| | StateControl | 0xA2 | 0xD6 | Drives the state of the GPO pin(1) |
| | SendInterrupt | 0xA2 | 0xD6 | Generates a pulse on the GPO pin(1) |

1. *Available on ST25TA02KB-D/P only*

## 6.1 Structure of the command sets

The exchange of data between the RF host and the ST25TAxxxB 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 acknowledgment
- 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.

## 6.2 I-Block format

The I-Block is used to exchange data between the RF host and the ST25TAxxxB. It is composed of three fields, as detailed in Table 14.

**Table 14. 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 ST25TAxxxB: C-APDU<br>ST25TAxxxB to RF host: R-APDU | | | | |
| 2 CRC bytes | | | | |

**Table 15. 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 ST25TAxxxB.

**ST25TAxxxB rules:**

- Rule C: The ST25TAxxxB block number shall be initialized to 1 at activation.
- Rule D: When an I-block is received, the ST25TAxxxB shall toggle its block number before sending a block.

*Note: The ST25TAxxxB 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 ST25TAxxxB block number is received, the ST25TAxxxB 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 ST25TAxxxB, the format of the payload is the C-APDU.

When the ST25TAxxxB sends a command to the RF host, the format of the payload is the R-APDU.

### 6.2.1 C-APDU: payload format of a command

The C-APDU format is used by the RF host to send a command to the ST25TAxxxB. Table 16 describes its format.

**Table 16. 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<br>- 0x00: standard command<br>- 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 ST25TAxxxB memory | | | | | | | |

1. See *Table 13. RF command sets*.

### 6.2.2 R-APDU: payload format of a response

The ST25TAxxxB use the I-Block format to reply to a command that has used the I-Block format. This format is described in Table 17.

**Table 17. R-APDU format**

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

## 6.3 R-Block format

The R-Block is used to convey positive or negative acknowledgment between the RF host and the ST25TAxxxB.

**Table 18. 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<br>R(ACK) with the DID field: 0xAA or 0xAB<br>R(NAK) without the DID field: 0xB2 or 0xB3<br>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 ST25TAxxxB
- R(NAK): the non-acknowledgment block sent by the RF host

**Table 19. PCB field of the R-Block format**

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

## 6.4 S-Block format

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

**Table 20. S-Block format**

| NFC frame | SoD | | - | EoD |
|---|---|---|---|---|
| | PCB | DID | Payload | CRC |
| Length | 1 byte | 1 byte | 1 byte | 2 bytes |
| S(DES) without the DID field : 0xC2<br>S(DES) with the DID field : 0xCA<br>S(WTX) without the DID field : 0xF2<br>S(WTX) with the DID field : 0xFA | | | | |
| 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 21. PCB field of the S-Block 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 the ST25TAxxxB 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 21. PCB field of the S-Block format**

| | b7-b6 | b5-b4 | b3 | b2 | b1 | b0 |
|---|---|---|---|---|---|---|
| | 0b11 | X | X | 0 | 1 | 0 |
| S-Block | | | | | | |
| 0b00: Deselect<br>0b11: WTX | | | | | | |
| 0: DID field is not present<br>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 ST25TAxxxB enter the Standby power mode.*

*In response to a RATS command, the ST25TAxxxB return the FWI parameter (default frame waiting time used); when the ST25TAxxxB need more time for a command execution, they request a frame waiting time extension by responding 0xF2 0xWTX*

*(Request waiting time = FWI * WTX). If the reader accepts the ST25TAxxxB request, it acknowledges the request by sending the command 0xF2 0xWTX. The frame waiting time becomes FWI * WTX for the current command only.*

## 6.5 CRC of the RF frame

The two CRC bytes check the data transmission between the RF host and the ST25TAxxxB. 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.

## 6.6 Status and error codes

This section lists the status and the error codes of the ST25TAxxxB.

**Table 22. Status code of the ST25TAxxxB**

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

**Table 23. Error codes of the ST25TAxxxB**

| | SW1 | SW2 | Comment |
|---|---|---|---|
| Length | 1 byte | 1 byte | |
| Value | 0x63 | 0x00 | Password is required |
| Value | 0x63 | 0xCX | Password is incorrect, X further retries allowed<br>(X can take values 0, 1 or 2) |
| Value | 0x65 | 0x81 | Unsuccessful updating |
| Value | 0x67 | 0x00 | Wrong frame 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 | 0x69 | 0x85 | Conditions of use not satisfied |
| 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 |

## 6.7 NFC Forum Type 4 Tag protocol

The ST25TAxxxB command set is built to easily support the NFC Forum Type 4 Tag protocol.

### 6.7.1 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 in addition to the sequence defined in the NFC Forum digital protocol.

Table 24 and Table 25 respectively define the C-APDU and R-APDU of the NDEF Tag Application Select command.

**Table 24. 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 25. 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 |
| Value | - | 0x6* | 0x** | Refer to Section 6.6 Status and error codes |

### 6.7.2 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 26 and Table 27 respectively define the C-APDU and R-APDU of the Capability Container Select command.

**Table 26. 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 27. 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 |
| Value | - | 0x6* | 0x** | Refer to Section 6.6 Status and error codes |

### 6.7.3 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 28 and Table 29 respectively define the C-APDU and R-APDU of the NDEF Select command.

**Table 28. 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 29. 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 |
| Value | - | 0x6* | 0x** | Refer to Section 6.6 Status and error codes |

### 6.7.4 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 30 and Table 31 respectively define the C-APDU and R-APDU of the System File Select command.

**Table 30. 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 31. 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 |
| Value | - | 0x6* | 0x** | Refer to Section 6.6 Status and error codes |

### 6.7.5 ReadBinary command

On receiving the ReadBinary command, the ST25TAxxxB read the requested memory field and send 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 start offset P1P2 is lower than LEN: the length of the selected file(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 32 and Table 33 respectively define the C-APDU and R-APDU of the ReadBinary command.

**Table 32. C-APDU of the ReadBinary command**

| Name | CLA | INS | P1 and P2 | Lc | Data | Le |
|---|---|---|---|---|---|---|
| - | 0x00 | 0xB0 | 2 bytes | - | - | 1 byte |
| Class byte | | | | | | |
| Read instruction code | | | | | | |
| Offset in the file selected 0x0000 ≤ P1P2 < LEN | | | | | | |
| (empty field) | | | | | | |
| (empty field) | | | | | | |
| Number of bytes to read: 0x00 ≤ Le ≤ MLe | | | | | | |

**Table 33. R-APDU of the ReadBinary command**

| | Data | SW1 | SW2 | Comment |
|---|---|---|---|---|
| Length | - | 1 byte | 1 byte | - |
| Value | Content read | 0x90 | 0x00 | Command completed |
| Value | - | 0x69 | 0x85 | Read access forbidden |
| Value | - | 0x6A | 0x80 | Wrong Le value (> MLe) |
| Value | - | 0x69 | 0x82 | Security status not satisfied |
| Value | - | 0x6A | 0x82 | File or application not found |
| Value | - | 0x6A | 0x86 | Wrong start address (P1P2 ≥ LEN) |
| Value | - | 0x6* | 0x** | Refer to Section 6.6 Status and error codes |

### 6.7.6 UpdateBinary command

On receiving the UpdateBinary command, the ST25TAxxxB write the data field into the selected file and send back a status in the R-APDU response. If needed, The ST25TAxxxB devices will request a timing extension (see Section 6.4 S-Block format).

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

Table 34 and Table 35 respectively define the C-APDU and R-APDU of the UpdateBinary command.

**Table 34. C-APDU of the UpdateBinary command**

| Name | CLA | INS | P1 and 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≤ MLc) | | | | | | |
| Data to write in the ST25TAxxxB memory | | | | | | |
| (empty field) | | | | | | |

**Table 35. 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 | - | 0x69 | 0x85 | Write access forbidden |
| Value | - | 0x6A | 0x80 | Wrong Lc value (0 or > MLc) |
| Value | - | 0x69 | 0x82 | Security status not satisfied |
| Value | - | 0x6A | 0x82 | File or application not found |
| Value | - | 0x6A | 0x86 | Wrong start address |
| Value | - | 0x6* | 0x** | Refer to Section 6.6 Status and error codes |

## 6.8 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.

### 6.8.1 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 grants access to the memory (Lc field = 0x10 and the password is present).

When the Lc field equals 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 tag responds the error code 0x6300 to the Verify command. When the access to the NDEF file is forbidden, the tag responds the error code 0x6984 to the Verify command.

When the Lc field equals 0x10, on receiving the Verify command, the ST25TAxxxB compare 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 password verification, an access is granted for the whole NDEF file.

Table 36 and Table 37 respectively define the C-APDU and R-APDU of the Verify command.

**Table 36. C-APDU of the Verify command**

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

**Table 37. R-APDU of the Verify command**

| | Data | SW1 | SW2 | Comment |
|---|---|---|---|---|
| Length | - | 1 byte | 1 byte | - |
| Value | - | 0x90 | 0x00 | No password required (Lc = 0x0) or correct password (Lc = 0x10) |
| Value | - | 0x69 | 0x84 | The conditions of use are not satisfied (e.g.the access to the NDEF file is forbidden) |
| 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 | The password transmitted is incorrect and X encodes the number of further allowed retries |
| Value | - | 0x6* | 0x** | Refer to Section 3.4 NDEF file passwords |

### 6.8.2 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 theNDEF file.

Table 38 and Table 39 respectively define the C-APDU and R-APDU of the Change Reference Data command.

**Table 38. C-APDU of the Change Reference Data command**

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

**Table 39. R-APDU of the Change Reference Data command**

| | Data | SW1 | SW2 | Comment |
|---|---|---|---|---|
| Length | 0 | 1 byte | 1 byte | - |
| Value | - | 0x90 | 0x00 | Command completed, the password value 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 | Incorrect parameter in file structure |
| Value | - | 0x6A | 0x82 | File or application not found |
| Value | - | 0x6A | 0x86 | Incorrect P1 or P2 values |
| Value | - | 0x6* | 0x** | Refer to Section 6.6 Status and error codes |

### 6.8.3 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.

The response time of the command is ~5 ms.

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

Table 40 and Table 41 respectively define the C-APDU and R-APDU of the Enable Verification Requirement command.

**Table 40. C-APDU of the Enable Verification Requirement command**

| Name | CLA | INS | P1 and P2 | Lc | Data | Le |
|---|---|---|---|---|---|---|
| - | 0x00 | 0x28 | 2 bytes | - | - | - |
| Class byte | | | | | | |
| Instruction code | | | | | | |
| New security attributes<br>0x0001: Enable the READ PROTECTED state<br>0x0002: Enable the WRITE PROTECTED state<br>Other: RFU | | | | | | |
| (empty field) | | | | | | |
| (empty field) | | | | | | |
| (empty field) | | | | | | |

**Table 41. R-APDU of the Enable Verification Requirement command**

| | Data | SW1 | SW2 | Comment |
|---|---|---|---|---|
| Length | 0 | 1 byte | 1 byte | - |
| Value | - | 0x90 | 0x00 | Protection mode changed to PROTECTED state |
| Value | - | 0x69 | 0x81 | Command is incompatible with the file structure |
| Value | - | 0x69 | 0x82 | Security status not satisfied |
| Value | - | 0x6A | 0x80 | Incorrect parameter in command data field |
| Value | - | 0x6A | 0x82 | File or application not found |
| Value | - | 0x6* | 0x** | Refer to Section 6.6 Status and error codes |

### 6.8.4 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 protection mode of the NDEF file.

This response time of the command is ~6 ms.

Table 42 and Table 43 respectively define the C-APDU and R-APDU of the Disable Verification Requirement command.

**Table 42. C-APDU of the Disable Verification Requirement command**

| Name | CLA | INS | P1 and P2 | Lc | Data | Le |
|---|---|---|---|---|---|---|
| - | 0x00 | 0x26 | 2 bytes | - | - | - |
| Class byte | | | | | | |
| Instruction code | | | | | | |
| New security attributes<br>0x0001: Enable the READ UNPROTECTED state<br>0x0002: Enable the WRITE UNPROTECTED state<br>Other: RFU | | | | | | |
| (empty filed) | | | | | | |
| (empty filed) | | | | | | |
| (empty filed) | | | | | | |

**Table 43. R-APDU of the Disable Verification Requirement command**

| | Data | SW1 | SW2 | Comment |
|---|---|---|---|---|
| Length | 0 | 1 byte | 1 byte | - |
| Value | - | 0x90 | 0x00 | Protection mode set to UNPROTECTED state |
| 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 | - | 0x65 | 0x81 | Update failed |
| Value | - | 0x6* | 0x** | Refer to Section 6.6 Status and error codes |

## 6.9 ST-proprietary command set

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

### 6.9.1 ExtendedReadBinary command

On receiving the ExtendedReadBinary command, the ST25TAxxxB read the requested memory field and send back its value in the R-APDU response.

The format and behavior of this command are identical to those of the ReadBinary command (see Section 6.7.5 ReadBinary command), the only difference being the value of the CLA field in the C-APDU as shown in Table 44. Refer to Table 33. R-APDU of the ReadBinary commandfor the list of return codes and definitions.

**Table 44. C-APDU of the ExtendedReadBinary command**

| Name | CLA | INS | P1 and 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 0x00 ≤ Le ≤ MLe | | | | | | |

### 6.9.2 EnablePermanentState command

This command configures the protection of the NDEF file to the READ FORBIDDEN or to the WRITE FORBIDDEN state.

This response time of the is ~6 ms.

Table 45 and Table 46 respectively define the C-APDU and R-APDU of the EnablePermanentState command.

**Table 45. C-APDU of the EnablePermanentState command**

| Name | CLA | INS | P1 and P2 | Lc | Data | Le |
|---|---|---|---|---|---|---|
| - | 0xA2 | 0x28 | 2 bytes | - | - | - |
| Class byte | | | | | | |
| Instruction code | | | | | | |
| New security attributes<br>0x0001: Enable the READ FORBIDDEN state<br>0x0002: Enable the WRITE FORBIDDEN state<br>Other: RFU | | | | | | |
| (empty field) | | | | | | |
| (empty field) | | | | | | |
| (empty field) | | | | | | |

**Table 46. R-APDU 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 |
| Value | - | 0x6A | 0x82 | File or application not found |
| Value | - | 0x6A | 0x86 | Incorrect P1 or P2 values |
| Value | - | 0x6* | 0x** | Refer to Section 6.6 Status and error codes |

### 6.9.3 UpdateFileType command

This command makes it possible to modify the value of the T field from the CC file (see Table 3. File identifier).

This command is successful only when application and file 0x0001 are selected and if the file length has previously been set to 0x0000 (message invalid) and protection modes have been set to READ UNPROTECTED and WRITE UNPROTECTED states.

The response time of the command is ~6 ms.

Table 47 and Table 48 respectively define the C-APDU and R-APDU of the UpdateFileType command.

**Table 47. C-APDU of the UpdateFileType command**

| Name | CLA | INS | P1 | P2 | Lc | Data | Le |
|---|---|---|---|---|---|---|---|
| Value | 0xA2 | 0xD6 | 0x00 | 0x00 | 0x01 | 1 byte | - |
| Class byte | | | | | | | |
| Select instruction code | | | | | | | |
| P1 field | | | | | | | |
| P2 field | | | | | | | |
| Number of bytes of data | | | | | | | |
| File type | | | | | | | |
| - | | | | | | | |

**Table 48. R-APDU 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 |
| Value | - | 0x6A | 0x86 | Incorrect P1 or P2 values |
| Value | - | 0x6* | 0x** | Refer to Section 6.6 Status and error codes |

### 6.9.4 SendInterrupt command

On receiving the SendInterrupt command, the ST25TA02KB-D or ST25TA02KB-P device generates a pulse on the GPO pin. It starts at the end of the command and ends at the end of the RF response.

Before sending this command, the system file shall be selected by issuing the System Select command.

Table 49 and Table 50 respectively define the C-APDU and R-APDU of the SendInterrupt command.

**Table 49. C-APDU of the SendInterrupt command**

| | CLA | INS | P1 and P2 | Lc | Data | Le |
|---|---|---|---|---|---|---|
| Length | 1 byte | 1 byte | 2 bytes | 1 byte | - | - |
| Value | 0xA2 | 0xD6 | 0x001E | 0x00 | - | - |

**Table 50. R-APDU of the SendInterrupt command**

| | Data | SW1 | SW2 | Comment |
|---|---|---|---|---|
| Length | - | 1 byte | 1 byte | - |
| Value | - | 0x90 | 0x00 | The interrupt has been sent |
| Value | - | 0x6A | 0x80 | The GPO is not configured as an interrupt mode |
| Value | - | 0x6A | 0x82 | File or application not found |
| Value | - | 0x6A | 0x86 | Incorrect P1 or P2 values |
| Value | - | 0x6E | 0x00 | Class not supported |

### 6.9.5 StateControl command

On receiving the StateControl command with activation value 0x00, the ST25TA02KB-D or ST25TA02KB-P device drives the GPO pin to active state. On receiving the StateControl command with deactivation value 0x01, the ST25TA02KB-D or ST25TA02KB-P device releases the GPO pin that returns to inactive state.

Before sending this command, the system file shall be selected by issuing the System Select command.

Table 51 and Table 52 respectively define the C-APDU and R-APDU of the StateControl command.

**Table 51. C-APDU of the StateControl command**

| | CLA | INS | P1 and P2 | Lc | Data | Le |
|---|---|---|---|---|---|---|
| Length | 1 byte | 1 byte | 2 bytes | 1 byte | - | - |
| Activation value | 0xA2 | 0xD6 | 0x001F | 0x01 | 0x00 | - |
| Deactivation value | 0xA2 | 0xD6 | 0x001F | 0x01 | 0x01 | - |

**Table 52. R-APDU of the StateControl command**

| | Data | SW1 | SW2 | Comment |
|---|---|---|---|---|
| Length | - | 1 byte | 1 byte | - |
| Value | - | 0x90 | 0x00 | The set or reset has been sent |
| Value | - | 0x6A | 0x80 | The GPO is not configured in StateControl mode |
| Value | - | 0x6A | 0x82 | File or application not found |
| Value | - | 0x6A | 0x86 | Incorrect P1 or P2 values |
| Value | - | 0x6E | 0x00 | Class not supported |

## 6.10 ISO14443-4 / NFC-A command set

This section describes the commands used to activate and deactivate the tag.

### 6.10.1 Anticollision command set

Table 53 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 53. Commands issued 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, ST25TAxxxB in the Operating Field transmit the requested cascade level of their NFCID1 (NFCID1 CLn, with n = 1 or 2). The NFCID1 of ST25TAxxxB 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 below for more details.*

**Table 54. Example of anticollision sequence**

| Command | Code | Comment | Response | Code | Comment |
|---|---|---|---|---|---|
| SENS_REQ or ALL-REQ | 26<br>52 | - | ATQA | 42 00 | UID double size bit frame anticollision |
| SDD_REQ 1 | 93 20 | NVB 20<br>Number Valid bit<br>(2 bytes Code and NVB) | - | CT uid1 uid2 uid3<br>BCC | CT Cascade Tag “0x88”<br>(UID 7bytes)<br>BCC Block Check Character<br>(XOR previous Bytes) |
| SEL_REQ 1 | 93 70 CT<br>uid1 uid2 uid3 BBC | NVB 70<br>(cmd NVB Uid lower bytes)<br>CT Cascade Tag “0x88” | SAK<br>and CRC | 04 DA17 | UID not complete |
| SDD_REQ 2 | 95 20 | NVB 20<br>Number Valid bit<br>(2 bytes Code and NVB) | - | uid4 uid5 uid6 uid7<br>BCC | (UID 7bytes)<br>BCC Block Check Character<br>(XOR previous Bytes) |
| SEL_REQ 1 | 95 70<br>uid4 uid5 uid6 uid7<br>BBC | NVB 70<br>(cmd NVB Uid Upper bytes) | SAK<br>and CRC | 20 FC70 | UID complete |

### 6.10.2 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 55 details the RATS command. This command shall be sent after the anticollision process, and expects an ATS response (detailed in Table 57) from the ST25TAxxxB device.

**Table 55. 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 56 gives the conversion from FSDI to FSD.

**Table 56. Conversion from FSDI to FSD**

| FSDI | 0x0 | 0x1 | 0x2 | 0x3 | 0x4 | 0x5 | 0x6 | 0x7 | 0x8 | 0x9-0xE | 0xF |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FSD | 16 | 24 | 32 | 40 | 48 | 64 | 96 | 128 | 256 | RFU | 256 |

The DID (Dynamic ID, optionally affected to the ST25TAxxxB by the host to address ST25TAxxxB in all commands) field defines the value of the addressed ST25TAxxxB.

If DID is not '0', the ST25TAxxxB ignore the command if it contains a DID different from the one affected to ST25TAxxxB during RATS.

**Table 57. ATS response**

| Name | TL | T0 | TA(1) | TB(1) | | TC(1) | CRC |
|---|---|---|---|---|---|---|---|
| Byte field | 0x05 | 0x75 | 0x80 | 0x60 | | 0x02 | 2 bytes |
| Bit field | - | - | - | b7-b4 | b3-b0 | - | - |
| Length of the ATS response | | | | | | | |
| FSCI = 5 → FSC = 64 bytes | | | | | | | |
| The maximum ascending data rate is 106 kbps<br>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 ST25TAxxxB are able to receive. The ST25TAxxxB are able to receive up to 64 bytes of command. If the RF host sends a command with more than 64 bytes, the ST25TAxxxB will be unable 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 ST25TAxxxB.

### 6.10.3 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 the user to change the ascending (RF host to ST25TAxxxB) and descending (ST25TAxxxB to RF host) data rates. Usage of this command is optional, as the ST25TAxxxB devices only support 106 Kb/s in both directions.

**Table 58. PPS command**

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

The ascending and descending data rates shall be coded as described in Table 59.

**Table 59. Ascending and descending data rate coding**

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

When the ST25TAxxxB receive a PPS request as described in Table 58, they return the following response. The data rate of this response is 106 kbps. Table 60 gives the details of the PPS response.

**Table 60. PPS response**

| Name | Response (PPSS) | | CRC |
|---|---|---|---|
| Byte field | 0xDX | | 2 bytes |
| Bit field | b7-b4 | b3-b0 | - |
| Description | Response code | DID field | CRC |

### 6.10.4 DESELECT command

DESELECT command and response are defined in ISO/IEC 14443-4, in the Protocol Deactivation of PICC Type A.

This command makes it possible to put the tag in Standby power mode (This state can also be reached by a shutdown of the RF field.)

It consists of an S(DES) request block (see Section 6.4 S-Block format) sent by the RF host and an S(DES) response sent as acknowledge by the tag.

# 7 Functional procedures

In addition to the NDEF Detection, NDEF Read and NDEF Write procedures described in the NFC Forum Type 4 Tag specification, the ST25TAxxxB devices support the procedures described in this section to manage the protection of the NDEF file.

## 7.1 Protecting an NDEF file

The RF host executes this procedure to enable the read or write protection of an NDEF file. This process can be reverted by the procedure described in Section 7.3 Unprotecting an NDEF file.

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Transmit the NDEF file Write password by using the Verify command
4. Activate the protection by sending the EnableVerificationRequirement command with the adequate security attribute (see Section 6.8.3 Enable Verification Requirement command)

## 7.2 Accessing a protected NDEF file

The RF host executes this procedure to access an NDEF file that has been previously protected by a password.

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Transmit the Read or Write password (according to the protected access) using the Verify command
4. Access the NDEF file using the ReadBinary or the UpdateBinary command

## 7.3 Unprotecting an NDEF file

The RF host executes this procedure to disable the read or write access protection of an NDEF file. This process can be reverted by the procedure described in Section 7.1 Protecting an NDEF file.

1. Select the NDEF Tag Application
2. Select the NDEF file
3. Transmit the NDEF file Write password by using the Verify command
4. Deactivate the protection by sending the DisableVerificationRequirement command with the adequate security attribute (see Section 6.8.4 Disable Verification Requirement command).

## 7.4 Locking an NDEF file

The RF host executes this procedure to permanently permanently forbid the read or write access to an NDEF file. Compared to the one described in Section 7.1 Protecting an NDEF file, this process cannot be reverted.

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 with the adequate security attribute (see Section 6.9.2 EnablePermanentState command)

## 7.5 Reaching the READ-ONLY state

The RF host executes this procedure to set the tag in the READ-ONLY state defined in the NFC T4T specification

1. Write a non-empty NDEF message using the NDEF Write procedure from the NFC T4T specification
2. Lock the write access using the procedure described in Section 7.4 Locking an NDEF file

## 7.6 Changing a password

The RF host executes this procedure to modify the read or write password used for the protection of the NDEF file

1. Select the NDEF Tag Application
2. Select the NDEF file

3. Transmit the old password value using the Verify command with the adequate security attribute (see Section 6.8.1 Verify command)
4. Transmit the new password value using the ChangeReferenceData command with the same security attribute (see Section 6.8.2 Change Reference Data command)

## 7.7 Changing the file type

The RF host executes this procedure to change the value of the T field from the CC file

1. Select the NDEF Tag Application
2. Select the file 0x0001 using the NDEF Select command
3. Unprotect all file accesses using the procedure detailed in Section 7.3 Unprotecting an NDEF file
4. Set the File Length to 0x0000 using the UpdateBinary command
5. Send an UpdateFileType command with the new T field value as data (see Section 6.9.3 UpdateFileType command)

**Caution:** If the T field is set to a value different from 0x04, the file 0x0001 is no longer an NDEF file but a proprietary file, and the tag is in a state out of the scope of the NFC Forum.

# 8 UID: unique identifier

Each ST25TAxxxB device is uniquely identified by a 7-byte 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 61 describes the UID format.

**Table 61. UID format**

| - | 0x02 | 1 byte (1) | 5 bytes |
|---|---|---|---|
| IC manufacturer code | | | |
| Product code | | | |
| Device number | | | |

1. *This byte is 0xE3 for ST25TA02KB, 0xA3 for ST25TA02KB-P, 0xF3 for ST25TA02KB-D and 0xE4 for ST25TA512B.*

# 9 Maximum ratings

Stressing the devices above the ratings listed in Table 62 may cause permanent damage to them. These are stress ratings only and operation of the devices 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 device reliability.

**Table 62. 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 |
| | | | - | 9(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 | | - | 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, $V_{SS}$ pad left floating | $V_{AC0}$ - $V_{AC1}$ (peak to peak) | - | 10 | V |
| $V_{ESD}$ | Electrostatic discharge voltage (human body model) (4) | AC0 - AC1 | - | 2000 | 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 W, R2 = 500 W).*

# 10 GPO characteristics

This section summarizes the operating and measurement conditions of the GPO feature. The DC and AC characteristics are derived from tests performed under the measurement conditions summarized in the following tables. The GPO I/O is CMOS compliant.

## 10.1 CMOS GPO characteristics (ST25TA02KB-P only)

**Table 63. CMOS GPO operating conditions**

| Symbol | Parameter | Min. | Max. | Unit |
|---|---|---|---|---|
| $V_{DCG}$ | GPO power supply | 1.65 | 5.5 | V |

**Table 64. CMOS GPO DC characteristics**

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{OL}$ | Output Low voltage (GPO) | $I_{OL}$ = 0.7 mA, $V_{DCG}$ = 1.65 V | - | - | 0.2 $V_{DCG}$ | V |
| $V_{OH}$ | Output High voltage (GPO) | $I_{OH}$ = -0.7 mA, $V_{DCG}$ = 1.65 V | 0.8 $V_{DCG}$ | - | - | |
| $V_{OL}$ | Output Low voltage (GPO) | $I_{OL}$ = 2 mA, $V_{DCG}$ = 2.7 V | - | - | 0.2 $V_{DCG}$ | |
| $V_{OH}$ | Output High voltage (GPO) | $I_{OH}$ = -2 mA, $V_{DCG}$ = 2.7 V | 0.8 $V_{DCG}$ | - | - | |
| $V_{OL}$ | Output Low voltage (GPO) | $I_{OL}$ = 4 mA, $V_{DCG}$ = 5.5 V | - | - | 0.2 $V_{DCG}$ | |
| $V_{OH}$ | Output High voltage (GPO) | $I_{OH}$ = -4 mA, $V_{DCG}$ = 5.5 V | 0.8 $V_{DCG}$ | - | - | |
| $I_{L_VDCG}$ | Input leakage ($V_{DCG}$) | $V_{DCG}$ = 1.8 V, T = 90 °C | - | 5 | 75 | nA |
| | | $V_{DCG}$ = 2.7 V, T = 90 °C | - | 6 | 100 | |
| | | $V_{DCG}$ = 5.5 V, T = 90 °C | - | 14 | 150 | |

**Table 65. CMOS GPO AC Characteristics**

| Symbol | Parameter | Test condition | Min. | Max. | Unit |
|---|---|---|---|---|---|
| t f (IO) out | Output fall time (1) | CL = 50 pF, $V_{DCG}$ = 1.65 V to 5.5 V | - | 90 (2) (3) | ns |
| t r (IO) out | Output rise time(1) | CL = 50 pF, $V_{DCG}$ = 1.65 V to 5.5 V | - | 90(3) | ns |

1. *$V_{ref(t)}$ output timing reference levels 0.3 $V_{DCG}$ to 0.7 $V_{DCG}$ V.*
2. *When GPO is set in RF Field detection mode, return to quiet position could request a longer time, depending upon ST25TAxxxB activity (~20 ms).*
3. *Characterization only on bench.*

*Note: The GPO (general purpose output) can sink or source at least 0.7 mA at 1.65 V, 2 mA at 2.7 V, and 4 mA at 5.5 V.*

## 10.2 Open drain GPO characteristics (ST25TA02KB-D only)

**Table 66. Open drain GPO operating conditions**

| Symbol | Parameter | Min. | Max. | Unit |
|---|---|---|---|---|
| $V_{PULL-UP}$ | Pull-up supply | 1.65 | 5.5 | V |

**Table 67. Open drain GPO DC characteristics**

| Symbol | Parameter | Test condition | Min. | Max. | Unit |
|---|---|---|---|---|---|
| $V_{OL}$ (1) | Output Low voltage (GPO) | $I_{OL}$ = 1 mA,<br>Pull-up supply = 1.65 to 5.5 V | - | 0.4 V | V |

1. *Characterized only.*

# 11 GPO parameters

This section lists typical (characterized only) timings of the GPO according to its configuration.

**Table 68. GPO timings measurement**

| GPO field | | I/F | Condition | Command | Symbol | Typ. | Unit |
|---|---|---|---|---|---|---|---|
| Session Open | 0x10 or 0x90 | RF | GPO in active state when session active | NDEF select | CmdEOFtoGPActive (1) | 170 | µs |
| | | | GPO returns in inactive state | Deselect | CmdEOFtoGPInactive (2) | 370 | |
| WIP | 0x20 or 0xA0 | RF | GPO in active state when programming | Update Binary | CmdEOFtoGPActive | 75 | µs |
| | | | | | Writing time duration (No time extension) | (3) | ms |
| Message In Progress | 0x30 or 0xB0 | RF | GPO in active state when modifying NDEF | UpdateBinary (Msg Length #0) | CmdEOFtoGPActive(1) | 75 | µs |
| | | | | UpdateBinary | Writing time duration (No time extension) | (3) | ms |
| Interrupt | 0x40 or 0xC0 | RF | GPO in active state after receiving an Interrupt command | SendInterrupt | CmdEOFtoGPActive(1) | 75 | µs |
| | | | | | Pulse duration | 540 | |
| State Control | 0x50 or 0xD0 | RF | GPO in active state when activated | StateControl(0) | CmdEOFtoGPActive(1) | 60 | µs |
| | | | GPO returns in inactive state when deactivated | StateControl(1) | CmdEOFtoGPInactive(2) | 60 | |
| RF Busy | 0x60 or 0xE0 | RF | GPO in active state after receiving an RF command | Anticollision command or start of RF disturb (4) | CmdSOFtoGPActive (5) | 6 | µs |
| | | RF | GPO returns in inactive state after deselection or RF command in another protocol | Deselect or end of RF disturb(4) | CmdEOFtoGPInactive(2) | 460 | |
| Field detect | 0x70 or 0xF0 | RF | GPO in active state when RF field is present | - | $t_{FDETON}$ | 140 | µs |
| | | | | | $t_{FDETOFF}$ | 20 | |

1. *CmdEOFtoGPActive equals CmdEOFtoGPHigh for ST25TA02KB-P, and CmdEOFtoGPLow for ST25TA02KB-D.*
2. *CmdEOFtoGPInactive equals CmdEOFtoGPLow for ST25TA02KB-P, and CmdEOFtoGPHz for ST25TA02KB-D.*
3. *Writing time is a function of the message length and is automatically managed by the ST25TA02KB-D and by the ST25TA02KB-P. The NDEF message is mapped on memory blocks of 16 bytes. Each basic block has a typical update time duration of 6 ms, including the internal verify.*
4. *Command using another RF protocol.*
5. *CmdSOFtoGPActive equals CmdSOFtoGPHigh for ST25TA02KB-P, and CmdSOFtoGPLow for ST25TA02KB-D.*

# 12 RF electrical parameters

This section summarizes the operating and measurement conditions, and the DC and AC characteristics of the devices 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 69. Default operating conditions**

| Symbol | Parameter | Min. | Max. | Unit |
|---|---|---|---|---|
| $T_A$ | Ambient operating temperature | -40 | 85 | °C |

**Table 70. RF characteristics**

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

1. *Time between command EOF and Response SOF when updating NDEF Message Length.*
2. *See Capacitor value in Table 72. Ordering information scheme*
3. *Characterized only, at room temperature only, measured at $V_{AC0}$-$V_{AC1}$ = 5 V peak to peak at 13.56 MHz.*

*Note: All timing characterizations 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 (ST25TAxxxB)*
- *Value of the coil: 2.5 µH*
- *Tuning frequency: 14.2 MHz.*

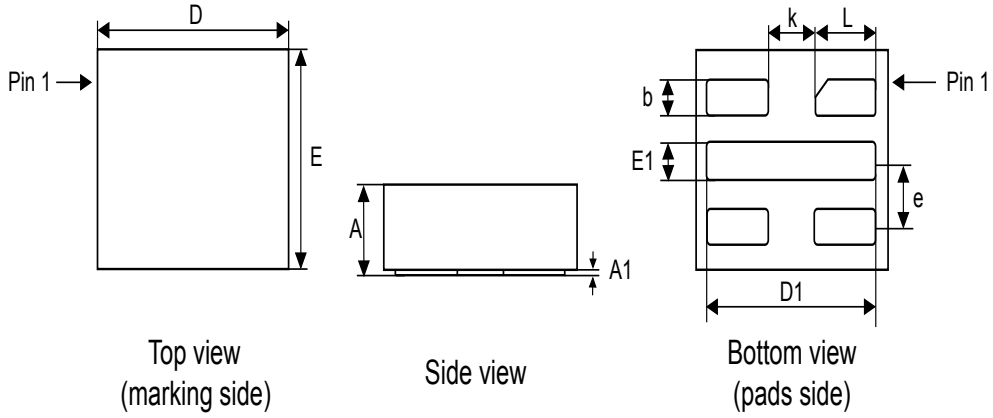
# 13 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com.

ECOPACK® is an ST trademark.

## 13.1 UFDFPN5 package information

**Figure 24. UFDFPN5 - 5-lead, 1.7 × 1.4 mm, 0.55 mm thickness package outline**




1. Max. package warpage is 0.05 mm.
2. Exposed copper is not systematic and can appear partially or totally according to the cross section.
3. Drawing is not to scale.

**Table 71. UFDFPN5 - 5-lead, 1.7 × 1.4 mm, 0.55 mm thickness package mechanical data**

| Symbol | millimeters | | | inches (1) | | |
|---|---|---|---|---|---|---|
| | Min | Typ | Max | Min | Typ | Max |
| A | 0.500 | 0.550 | 0.600 | 0.0197 | 0.0217 | 0.0236 |
| A1 | 0.000 | - | 0.050 | 0.0000 | - | 0.0020 |
| b (2) | 0.175 | 0.200 | 0.225 | 0.0069 | 0.0079 | 0.0089 |
| D | 1.600 | 1.700 | 1.800 | 0.0630 | 0.0669 | 0.0709 |
| D1 | 1.400 | 1.500 | 1.600 | 0.0551 | 0.0591 | 0.0630 |
| E | 1.300 | 1.400 | 1.500 | 0.0512 | 0.0551 | 0.0591 |
| E1 | 0.175 | 0.200 | 0.225 | 0.0069 | 0.0079 | 0.0089 |
| e | - | 0.400 | - | - | 0.0157 | - |
| L | 0.500 | 0.550 | 0.600 | 0.0197 | 0.0217 | 0.0236 |
| L1 | - | 0.100 | - | - | 0.0039 | - |
| k | - | 0.400 | - | - | 0.0157 | - |

1. *Values in inches are converted from mm and rounded to 4 decimal digits.*
2. *Dimension b applies to plated terminal and is measured between 0.15 and 0.30mm from the terminal tip.*

# 14 Ordering information

**Table 72. Ordering information scheme**

Example: ST25 T A 02K/512 B -A/P/D C 6 F/G/H 5

**Device type**

ST25 = RF memory

**Product type**

T = Tags + RFID

**Protocol**

A = ISO14443-A

**Memory density**

02K = 2 Kbits

512 = 512 bits

**Product version**

B = Version B

**Interface**

A = None

P = P-CMOS GPO

D = Open drain GPO

**Features**

C= Counter

**Operating temperature**

6 = - 40 °C to 85 °C

**Package**

F = Sawn and bumped wafer, 75 ± 10 µm

G= Sawn and bumped wafer, 120 ± 10 µm

H = UFDFPN5 package (ST25TA02KB-D and ST25TA02KB-D only)

**Capacitance**

5 = 50 pF

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

# Revision history

Table 73. **Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 13-Nov-2017 | 1 | Initial release. |
| 27-Sep-2018 | 2 | Added:<br>• Section 4.2.1 Inactive configuration (GPO field = 0x00 or 0x80)<br>Updated:<br>• Section 4.2 General purpose output (GPO), only available on ST25TA02KB-D/P<br>• Section 4.2.2 Session Open configuration (GPO field = 0x10 or 0x90) |

# Contents

1 **Functional description** . . . . . 2
1.1 Functional mode . . . . . 4
1.1.1 Tag mode . . . . . 5
2 **Signal description** . . . . . 6
2.1 Antenna coil (AC0, AC1) . . . . . 6
2.2 Ground (VSS), only available on ST25TA02KB-P and ST25TA02KB-D. . . . . 6
2.3 GPO supply voltage (VDCG), only available on ST25TA02KB-P . . . . . 6
2.3.1 Operating supply voltage VDCG . . . . . 6
2.3.2 Power-up conditions . . . . . 6
2.4 General purpose output (GPO), only available on ST25TA02KB-P and ST25TA02KB-D . . . 6
3 **ST25TAxxxB memory management** . . . . . 7
3.1 Memory structure . . . . . 7
3.1.1 File identifier . . . . . 7
3.1.2 CC file layout. . . . . 7
3.1.3 NDEF file layout . . . . . 8
3.1.4 System file layout . . . . . 9
3.2 Read and write access rights to the NDEF file . . . . . 10
3.2.1 Read and Write protection modes . . . . . 11
3.2.2 Read and Write access conditions . . . . . 11
3.2.3 Changing the read protection mode . . . . . 12
3.2.4 Changing the write protection mode . . . . . 12
3.3 Granted access life time . . . . . 13
3.4 NDEF file passwords . . . . . 13
4 **Specific features** . . . . . 14
4.1 Read/Write counter . . . . . 14
4.2 General purpose output (GPO), only available on ST25TA02KB-D/P . . . . . 14
4.2.1 Inactive configuration (GPO field = 0x00 or 0x80) . . . . . 14
4.2.2 Session Open configuration (GPO field = 0x10 or 0x90) . . . . . 15
4.2.3 WIP Writing in Progress configuration (GPO field = 0x20 or 0xA0) . . . . . 16
4.2.4 MIP NDEF Message writing in Progress configuration (GPO field = 0x30 or 0xB0). . . . . 17

4.2.5 INT Interrupt configuration (GPO field = 0x40 or 0xC0) . . . 18
4.2.6 State Control configuration (GPO field = 0x50 or 0xD0) . . . 19
4.2.7 RF busy configuration (GPO field = 0x60 or 0xE0) . . . 20
4.2.8 Field detect configuration (GPO field = 0x70 or 0xF0) . . . 21
4.3 TruST25™ digital signature feature . . . 21
**5 Communication mechanism . . . 22**
5.1 Master and slave . . . 22
**6 RF command sets . . . 23**
6.1 Structure of the command sets . . . 24
6.2 I-Block format . . . 24
6.2.1 C-APDU: payload format of a command . . . 25
6.2.2 R-APDU: payload format of a response . . . 26
6.3 R-Block format . . . 26
6.4 S-Block format . . . 27
6.5 CRC of the RF frame . . . 29
6.6 Status and error codes . . . 29
6.7 NFC Forum Type 4 Tag protocol . . . 30
6.7.1 NDEF Tag Application Select command . . . 30
6.7.2 Capability Container Select command . . . 31
6.7.3 NDEF Select command . . . 31
6.7.4 System File Select command . . . 32
6.7.5 ReadBinary command . . . 32
6.7.6 UpdateBinary command . . . 33
6.8 ISO/IEC 7816-4 commands . . . 34
6.8.1 Verify command . . . 34
6.8.2 Change Reference Data command . . . 35
6.8.3 Enable Verification Requirement command . . . 36
6.8.4 Disable Verification Requirement command . . . 37
6.9 ST-proprietary command set . . . 38
6.9.1 ExtendedReadBinary command . . . 38
6.9.2 EnablePermanentState command . . . 38

6.9.3 UpdateFileType command . . . 39
6.9.4 SendInterrupt command . . . 40
6.9.5 StateControl command . . . 40
6.10 ISO14443-4 / NFC-A command set . . . 42
6.10.1 Anticollision command set . . . 42
6.10.2 RATS command and ATS response . . . 43
6.10.3 PPS command and response . . . 44
6.10.4 DESELECT command . . . 44
**7 Functional procedures . . . 45**
7.1 Protecting an NDEF file . . . 45
7.2 Accessing a protected NDEF file . . . 45
7.3 Unprotecting an NDEF file . . . 45
7.4 Locking an NDEF file . . . 45
7.5 Reaching the READ-ONLY state . . . 45
7.6 Changing a password . . . 45
7.7 Changing the file type . . . 46
**8 UID: unique identifier . . . 47**
**9 Maximum ratings . . . 48**
**10 GPO characteristics . . . 49**
10.1 CMOS GPO characteristics (ST25TA02KB-P only) . . . 49
10.2 Open drain GPO characteristics (ST25TA02KB-D only) . . . 50
**11 GPO parameters . . . 51**
**12 RF electrical parameters . . . 52**
**13 Package information . . . 53**
13.1 UFDFPN5 package information . . . 53
**14 Ordering information . . . 54**
**Revision history . . . 55**
**Contents . . . 56**
**List of tables . . . 59**
**List of figures . . . 61**

# List of tables

Table 1. Signal names . . . 3
Table 2. Functional mode . . . 4
Table 3. File identifier . . . 7
Table 4. CC file layout . . . 7
Table 5. NDEF file layout . . . 8
Table 6. Field list . . . 9
Table 7. Details about the Counter configuration field . . . 10
Table 8. Details about the GPO field . . . 10
Table 9. Read protection modes . . . 11
Table 10. Write protection modes . . . 11
Table 11. Read access conditions (CCRD values) . . . 11
Table 12. Write access conditions (CCWR values) . . . 11
Table 13. RF command sets . . . 23
Table 14. I-Block format . . . 24
Table 15. PCB field of the I-Block format . . . 24
Table 16. C-APDU format . . . 25
Table 17. R-APDU format . . . 26
Table 18. R-Block format . . . 26
Table 19. PCB field of the R-Block format . . . 27
Table 20. S-Block format . . . 27
Table 21. PCB field of the S-Block format . . . 28
Table 22. Status code of the ST25TAxxxB . . . 29
Table 23. Error codes of the ST25TAxxxB . . . 29
Table 24. C-APDU of the NDEF Tag Application Select command . . . 30
Table 25. R-APDU of the NDEF Tag Application Select command . . . 30
Table 26. C-APDU of the Capability Container Select command . . . 31
Table 27. R-APDU of the Capability Container Select command . . . 31
Table 28. C-APDU of the NDEF Select command . . . 31
Table 29. R-APDU of the NDEF Select command . . . 32
Table 30. C-APDU of the System File Select command . . . 32
Table 31. R-APDU of the System File Select command . . . 32
Table 32. C-APDU of the ReadBinary command . . . 33
Table 33. R-APDU of the ReadBinary command . . . 33
Table 34. C-APDU of the UpdateBinary command . . . 33
Table 35. R-APDU of the UpdateBinary command . . . 34
Table 36. C-APDU of the Verify command . . . 34
Table 37. R-APDU of the Verify command . . . 35
Table 38. C-APDU of the Change Reference Data command . . . 35
Table 39. R-APDU of the Change Reference Data command . . . 36
Table 40. C-APDU of the Enable Verification Requirement command . . . 36
Table 41. R-APDU of the Enable Verification Requirement command . . . 37
Table 42. C-APDU of the Disable Verification Requirement command . . . 37
Table 43. R-APDU of the Disable Verification Requirement command . . . 38
Table 44. C-APDU of the ExtendedReadBinary command . . . 38
Table 45. C-APDU of the EnablePermanentState command . . . 39
Table 46. R-APDU of the EnablePermanentState command . . . 39
Table 47. C-APDU of the UpdateFileType command . . . 39
Table 48. R-APDU of the UpdateFileType command . . . 40
Table 49. C-APDU of the SendInterrupt command . . . 40
Table 50. R-APDU of the SendInterrupt command . . . 40
Table 51. C-APDU of the StateControl command . . . 41
Table 52. R-APDU of the StateControl command . . . 41

Table 53. Commands issued by the RF host . . . 42
Table 54. Example of anticollision sequence . . . 42
Table 55. RATS command . . . 43
Table 56. Conversion from FSDI to FSD . . . 43
Table 57. ATS response . . . 43
Table 58. PPS command . . . 44
Table 59. Ascending and descending data rate coding . . . 44
Table 60. PPS response . . . 44
Table 61. UID format . . . 47
Table 62. Absolute maximum ratings . . . 48
Table 63. CMOS GPO operating conditions . . . 49
Table 64. CMOS GPO DC characteristics . . . 49
Table 65. CMOS GPO AC Characteristics . . . 49
Table 66. Open drain GPO operating conditions . . . 50
Table 67. Open drain GPO DC characteristics . . . 50
Table 68. GPO timings measurement . . . 51
Table 69. Default operating conditions . . . 52
Table 70. RF characteristics . . . 52
Table 71. UFDFPN5 - 5-lead, 1.7 × 1.4 mm, 0.55 mm thickness package mechanical data . . . 53
Table 72. Ordering information scheme . . . 54
Table 73. Document revision history . . . 55

# List of figures

Figure 1. Block diagram - ST25TA02KB and ST25TA512B . . . 2
Figure 2. Block diagram - ST25TA02KB-P . . . 2
Figure 3. Block diagram - ST25TA02KB-D . . . 3
Figure 4. 5-pin package connections - ST25TA02KB-D . . . 3
Figure 5. 5-pin package connections - ST25TA02KB-P . . . 3
Figure 6. Applicative example of GPO usage - ST25TA02KB-D . . . 4
Figure 7. Applicative example of GPO usage - ST25TA02KB-P . . . 5
Figure 8. Changing the read protection mode . . . 12
Figure 9. Changing the write protection mode . . . 12
Figure 10. CMOS GPO configured as Session Open (GPO field = 0x10 or 0x90) . . . 15
Figure 11. Open drain GPO configured as Session Open (GPO field = 0x10 or 0x90) . . . 15
Figure 12. CMOS GPO configured as WIP (GPO field = 0x20 or 0xA0) . . . 16
Figure 13. Open drain GPO configured as WIP (GPO field = 0x20 or 0xA0) . . . 16
Figure 14. CMOS GPO configured as MIP (GPO field = 0x30 or 0xB0) . . . 17
Figure 15. Open drain GPO configured as MIP (GPO field = 0x30 or 0xB0) . . . 17
Figure 16. CMOS GPO configured as INT (GPO field = 0x40 or 0xC0) . . . 18
Figure 17. Open drain GPO configured as INT (GPO field = 0x40 or 0xC0) . . . 18
Figure 18. CMOS GPO configured as State Control (GPO field = 0x50 or 0xD0) . . . 19
Figure 19. Open drain GPO configured as State Control (GPO field = 0x50 or 0xD0) . . . 19
Figure 20. CMOS GPO configured as RF busy (GPO field = 0x60 or 0xE0) . . . 20
Figure 21. Open drain GPO configured as RF busy (GPO field = 0x60 or 0xE0) . . . 20
Figure 22. CMOS GPO configured as Field detect (GPO field = 0x70 or 0xF0) . . . 21
Figure 23. Open drain GPO configured as Field detect (GPO field = 0x70 or 0xF0) . . . 21
Figure 24. UFDFPN5 - 5-lead, 1.7 × 1.4 mm, 0.55 mm thickness package outline . . . 53

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