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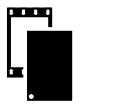
ST25TA02K-D

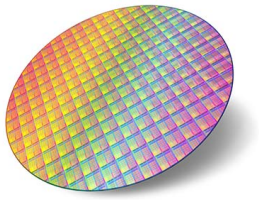
NFC Forum Type 4 Tag IC with 2-Kbit EEPROM and general purpose digital output

Datasheet - production data



UFDFPN8

UFDFPN5



Wafer

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

- 256-byte (2-kbit) EEPROM
- Supports NDEF data structure
- Data retention: 200 years
- Endurance: 1 million erase-write cycles
- Reads up to 255 bytes in a single command
- Writes 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
- RF field detect

Package

- UFDFPN8 ECOPACK®2
- UFDFPN5 ECOPACK®2

Digital pad

- GPO: configurable general purpose output driven by an open drain transistor.

Description

The ST25TA02K-D device is a dynamic NFC/RFID tag IC with a general purpose digital output.

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

The ST25TA02K-D is an NFC Forum Type 4 Tag; it communicates using the ISO/IEC 14443 Type A protocol.

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1 Functional description

The ST25TA02K-D device is a dynamic NFC/RFID tag that can be accessed from the RF interface. The RF interface is based on the ISO/IEC 14443 Type A standard. The ST25TA02K-D is compatible with the NFC Forum Type 4 Tag specifications and supports all corresponding commands.

Figure 1 displays the block diagram of the ST25TA02K-D device.

Figure 1. ST25TA02K-D block diagram

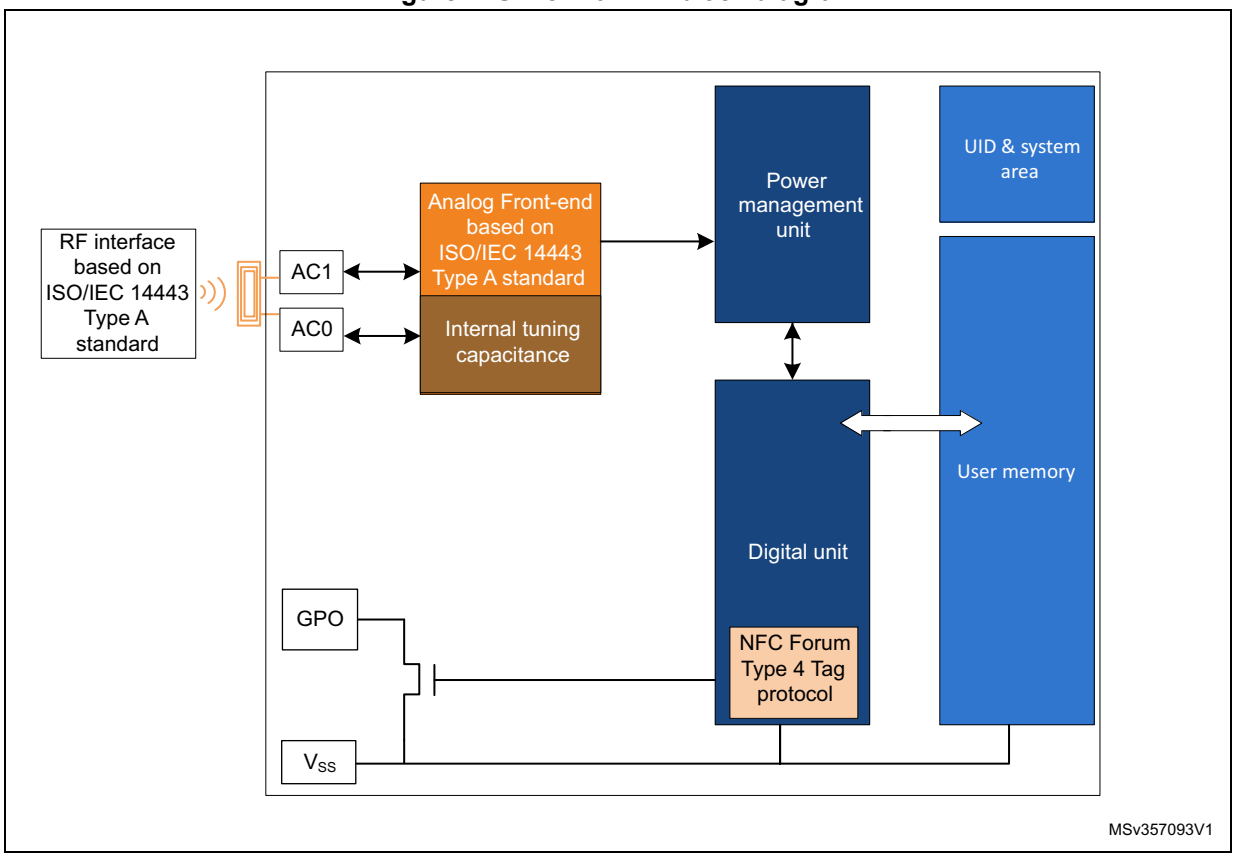
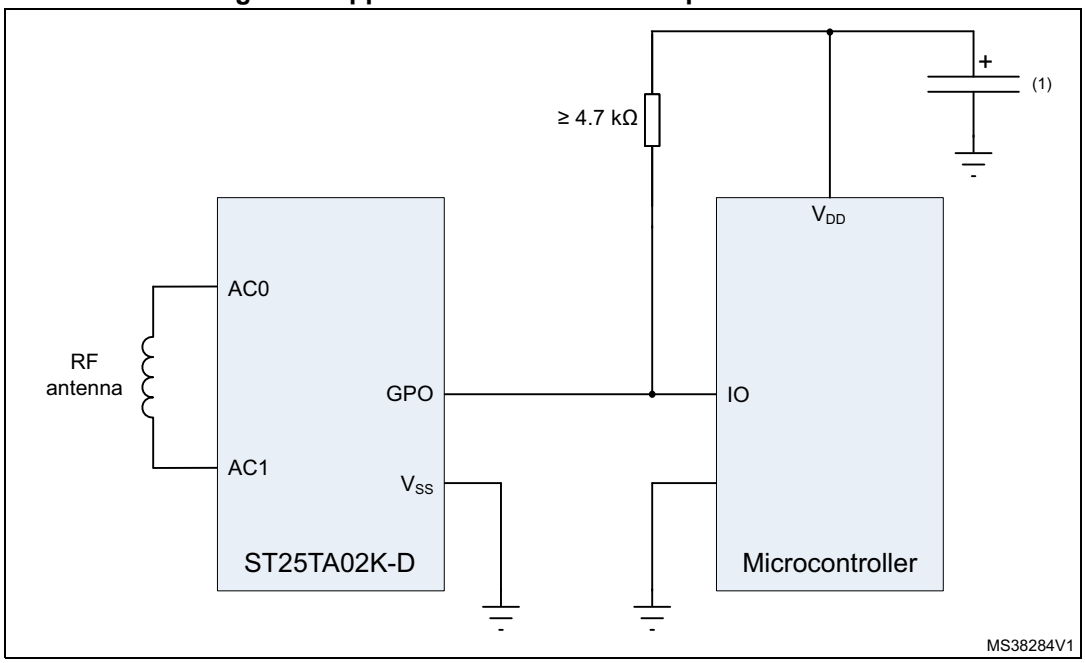


Figure 2. Applicative schematic example



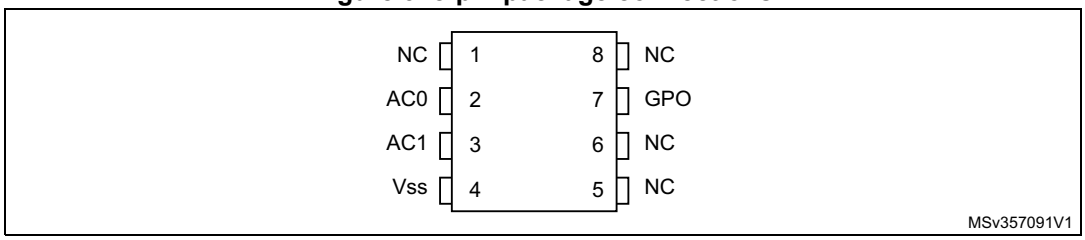
1. Decoupling capacitor

Table 1. Signal names

Signal name	Function	Direction
AC0, AC1	Antenna coils	-
V_{SS}	Ground	-
GPO	Interrupt output (1)	Open drain output(1)

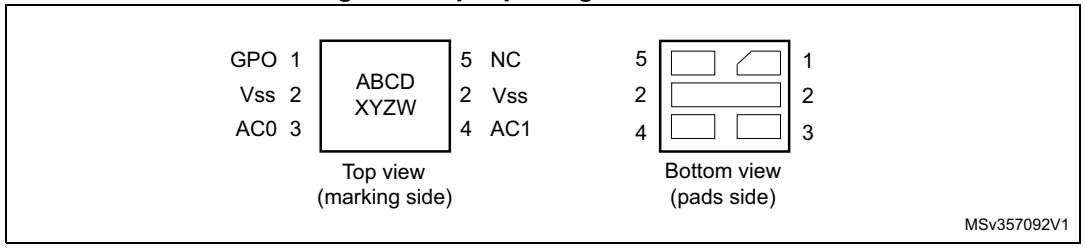
1. An external pull-up > 4.7 kΩ is required.

Figure 3. 8-pin package connections



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

Figure 4. 5-pin package connections



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

1.1 Functional modes

The ST25TA02K-D has just one functional mode available (see *Table 2*).

Table 2. Functional mode

Mode	Supply source	Comments
Tag mode	RF field only	The RF interface is connected, GPO Open drain transistor request an external Pull-up (>4.7 KOhm) to operate.

1.1.1 Tag mode

The ST25TA02K-D is supplied by the RF field and can communicate with an RF host (RFID reader or an NFC phone). The User memory can be accessed by the RF commands.

2 Signal descriptions

2.1 Antenna coil (AC0, AC1)

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

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

2.2 Ground (V_{SS})

V_{SS}, when connected, is the reference for the GPO and the other pads, even AC0 and AC1.

2.3 General Purpose Output (GPO)

The GPO pad is an open drain pad and a external pull-up resistor shall be connected to it.

This pad is a configurable output signal, driven a low level when configured event occurs, otherwise it remains in an high impedance state. 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[(a)]:

- 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 ST25TA02K-D is executing a writing operation.
- INT (interrupt): the RF host can force the ST25TA02K-D 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 ST25TA02K-D.
- Field detection: the RF field is sufficient to establish an RF communication with the ST25TA02K-D.

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.

a. See *Table 65: GPO timings measurement* for more details.

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

When the GPO is configured as "Session Open", it goes to the low state when an RF session is ongoing (see *Figure 5*).

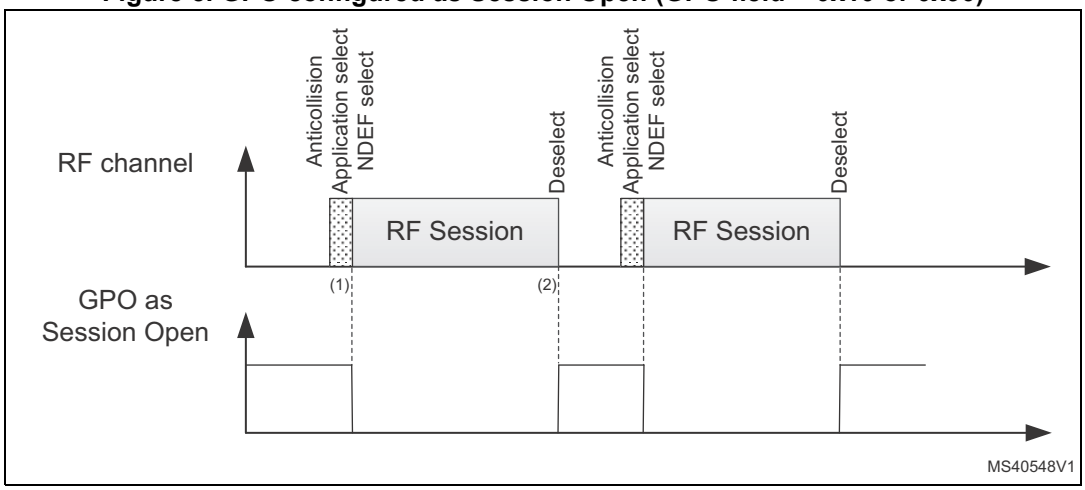
An RF session is taken when ST25TA02K-D receives a valid Select Application. The session is released when:

- ST25TA02K-D receives a valid Deselect command
- RF field becomes OFF

GPO is driven low after a delay (*1.*) when the session is open.

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

Figure 5. 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)

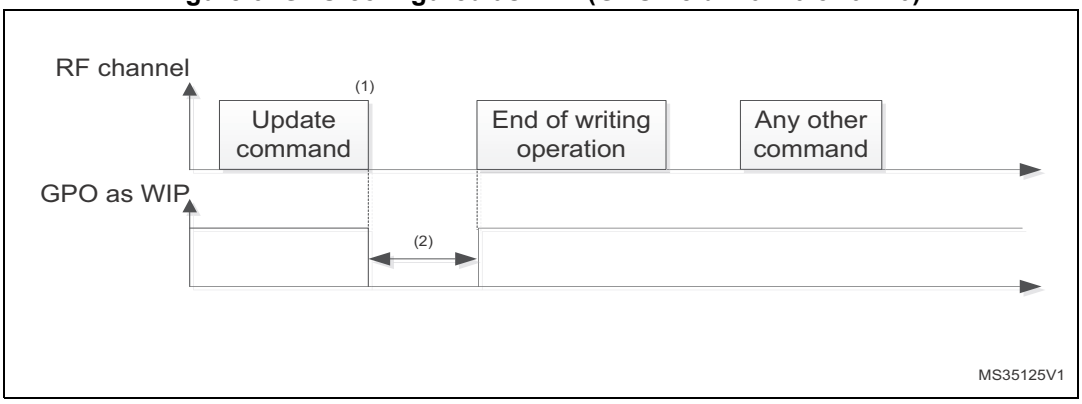
2.3.2 WIP Writing in Progress configuration (GPO field = 0x20 or 0xA0)

When the GPO is configured as "WIP", it goes to the low state during an RF writing operation (see *Figure 6*).

During an RF session, when ST25TA02K-D updates a file, GPO is driven low after a delay (*1.*) following the beginning of the correspondent UpdateBinary command execution.

GPO will remain low during the writing time (*2.*), before being released.

Figure 6. GPO configured as WIP (GPO field = 0x20 or 0xA0)



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

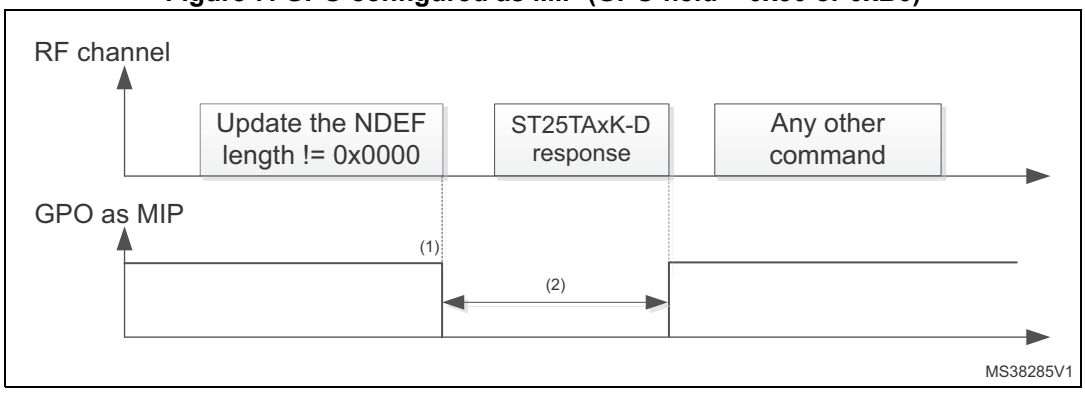
2.3.3 MIP NDEF Message writing in Progress configuration (GPO field = 0x30 or 0xB0)

When the GPO is configured as MIP, its state goes to the low state when the RF host writes the NDEF length to another value than 0x0000 (see *Figure 7*).

During an RF session, when ST25TA02K-D changes an NDEF file and updates the NDEF length with a value different from 0x0000, GPO is driven low after a delay (*1.*) following the beginning of the correspondent UpdateBinary command execution.

GPO will remain low during the writing time (*2.*), before being released.

Figure 7. GPO configured as MIP (GPO field = 0x30 or 0xB0)



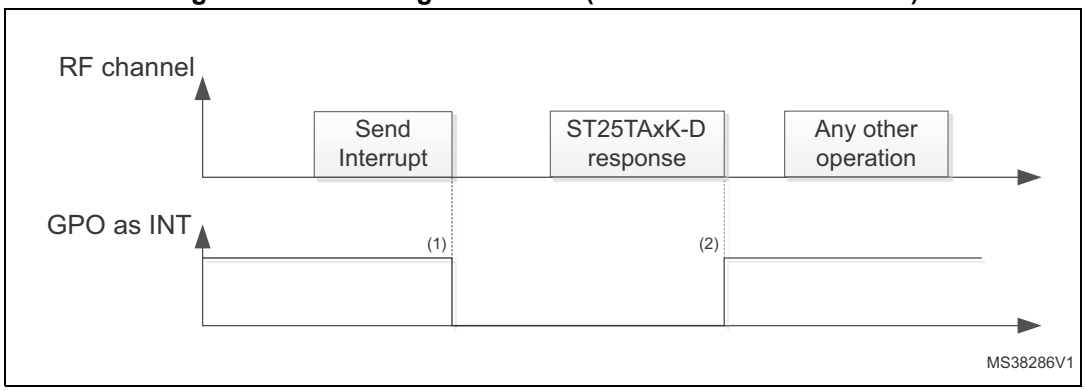
1. CmdEOFtoGPlow (RF command End of frame to GPO low)
2. Writing time duration

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

The RF host can send a negative pulse on the GPO pad. The GPO pad goes to high state at the end of the command and goes to the high state at the end of the ST25TA02K-D response (see *Figure 8*).

During an RF session, when ST25TA02K-D receives a valid Interrupt command, ST25TA02K-D GPO pin is driven low after (*1.*). Then GPO pin is released at the end of the response (*2.*).

Figure 8. GPO configured as INT (GPO field = 0x40 or 0xC0)



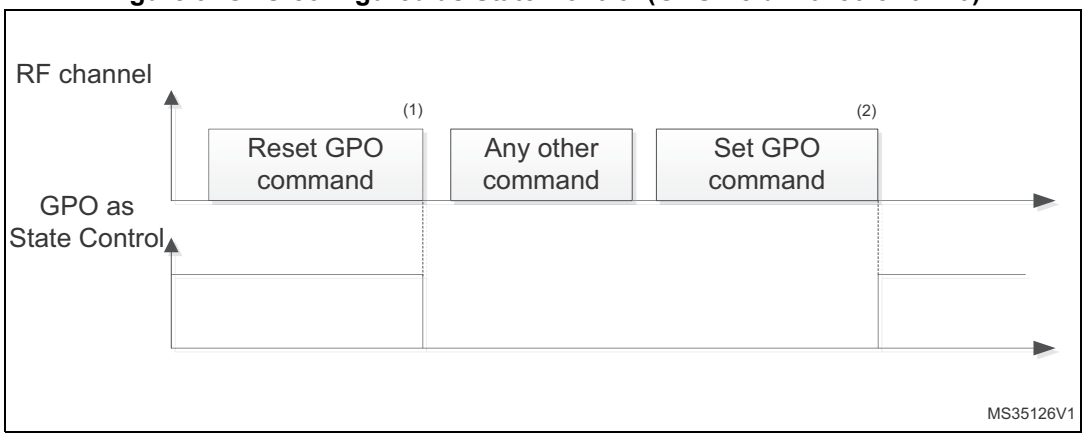
1. CmdEOFtoGPlow (RF command End of frame to GPO low)
2. RespEOFGPlow

2.3.5 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 9*).

During an RF session, the ST25TA02K-D can control the GPO pin. After receiving a valid reset GPO command, GPO pin is driven low after a delay (*1.*). GPO will be released after a valid Set command or after a Power off.

Figure 9. GPO configured as State Control (GPO field = 0x50 or 0xD0)



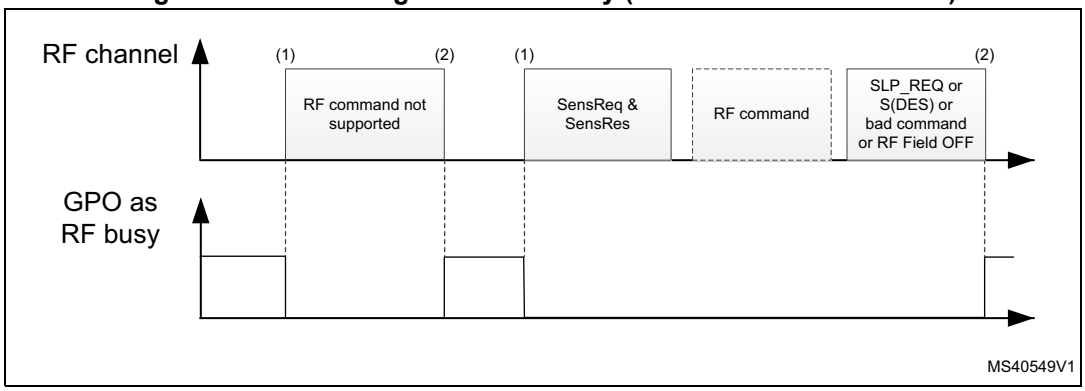
1. CmdEOFtoGPlow (RF Reset GPO command End of frame to GPO low)
2. CmdEOFtoGPHZ (RF Set GPO command End of frame to GPO HZ)

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

When the GPO is configured as RF busy, the GPO goes to the low state, both when the ST25TA02K-D is processing an RF command or when an RF session is ongoing (see *Figure 10*).

When an RF field is present, GPO is driven low after a delay (*1.*) when ST25TA02K-D detects the first command. If the RF session is ongoing and ST25TA02K-D receives a not-supported command, GPO remains low. It will be released only at the end of the RF session, after (*2.*).

Figure 10. GPO configured as RF busy (GPO field = 0x60 or 0xE0)



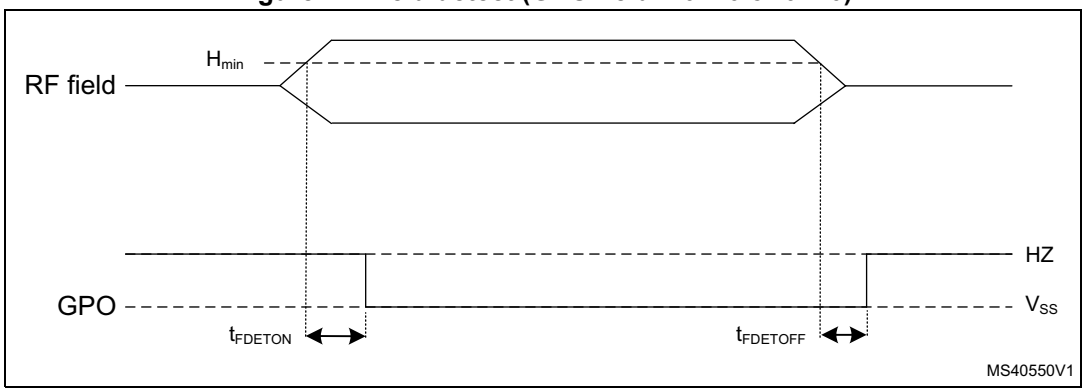
1. CmdSOFtoGPlow (RF command Start of frame to GPO low)
2. CmdEOFtoGPHZ (RF command End of frame to GPO HZ)

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

When the GPO is configured as Field detect, the GPO goes to the low state when ST25TA02K-D detects an RF Field (see *Figure 11*).

When an RF field is present, GPO is driven low after a delay when ST25TA02K-D detects this field. Whatever the activity during the RF field detection (communication with the reader or not), GPO will stay low. It will be released when ST25TA02K-D leaves the RF field.

Figure 11. Field detect (GPO field = 0x70 or 0xF0)



3 ST25TA02K-D memory management

3.1 Memory structure

The ST25TA02K-D supports the NDEF Tag Application as defined in the NFC Forum Type 4 Tag. The ST25TA02K-D is 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 ST25TA02K-D device. The CC file gives some information about the ST25TA02K-D itself and the NDEF file. The NDEF file contains the User data.

3.1.1 File identifier

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

Table 3. File identifier

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

3.1.2 CC file layout

The CC file gives some information about the ST25TA02K-D and the NDEF file. This file is a read-only file for the RF host and cannot be modified by issuing a write command.

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

Table 4. CC file layout for 1 NDEF file

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

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

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

1. According to the reader command format ST25TA02K-D will automatically align to the corresponding NFC Forum version.
2. Delivery state.

3.1.3 NDEF file layout

The NDEF file contains the NDEF message which contains the User data. The RF host can read and write data inside the file. The first two bytes named NDEF Message Length define the size of the NDEF message. The NDEF Message Length shall be managed by the application and the ST25TA02K-D device does not check if its value is relevant vs the data written by the RF host. The ST25TA02K-D device uses the NDEF Message Length, e. g. the standard read can be processed only inside the NDEF message; otherwise, the ST25TA02K-D device returns an error code. For more details about the read command, refer to *Section 5.6.7: ReadBinary command*.

Table 5. NDEF file layout

File offset	Byte 0	Byte 1	Byte 2	Byte 3
0x0000	NDEF Message Length		User data	User data
0x0004	User data	User data	User data	User data
...	...	...	...	...
...	...	...	...	...
...	...	...	...	...
0x00FC	...	...	...	User data

3.1.4 System file layout

The system file specifies the configuration of the ST25TA02K-D. *Table 6* lists the different fields.

Table 6. Field list

File offset	Field name	No. of bytes	Read access	Write access	Delivery state
0x0000	Length system file	2	yes	-	0x0012
0x0002	GPO Config	1	yes	yes(1)	0x70(2)
0x0003	Event Counter(3) Config	1	yes	yes(1)	0x00
0x0004	20 bits counter (MS nibble 0x0)	3	yes	none	0x000000
0x0007	Product version	1	yes	none	0x13(4)
0x0008	UID	7	yes	none	0x02F2 xx xx xx xx xx(5)
0x000F	Memory Size - 1	2	yes	none	0x00FF
0x0011	IC reference code	1	yes	none	0xF2

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 default GPO configuration.
3. Counter is not activated by default.
4. ST reserved.
5. x values are defined by ST to ensure UID unicity.

Table 7. Details about the GPO field

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

Warning: **When GPO config lock bit is set to “1”, the whole byte cannot be changed anymore.**

Table 8. Details about the Counter config field

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

3.2 Read and write access rights to the NDEF File

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

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

The read password shall be sent to the ST25TA02K-D device before reading a read-locked NDEF file.

The write password shall be present on the ST25TA02K-D device before writing a write-locked NDEF file. The write password shall be sent to change the read or write access. The read or write access right is defined for the NDEF file.

3.2.1 State of the Read and Write access rights

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

Table 9. Read access right

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

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

Table 10. Write access right

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

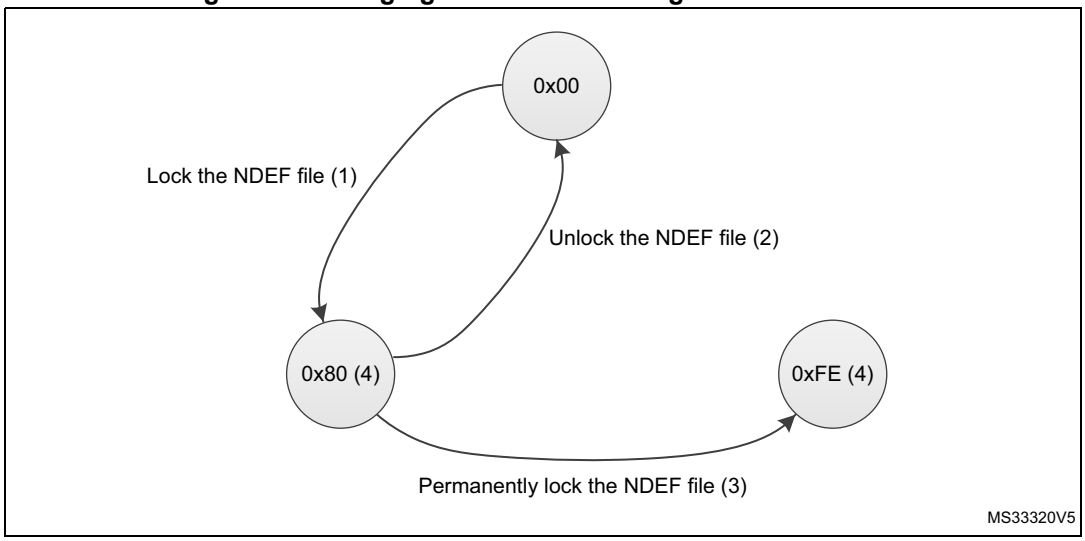
1. The write password shall be sent before writing in the NDEF file.

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

3.2.2 Changing the read access right to NDEF files

The state diagram in *Figure 12* shows how to change the access right to read an NDEF file.

Figure 12. Changing the read access right to an NDEF file

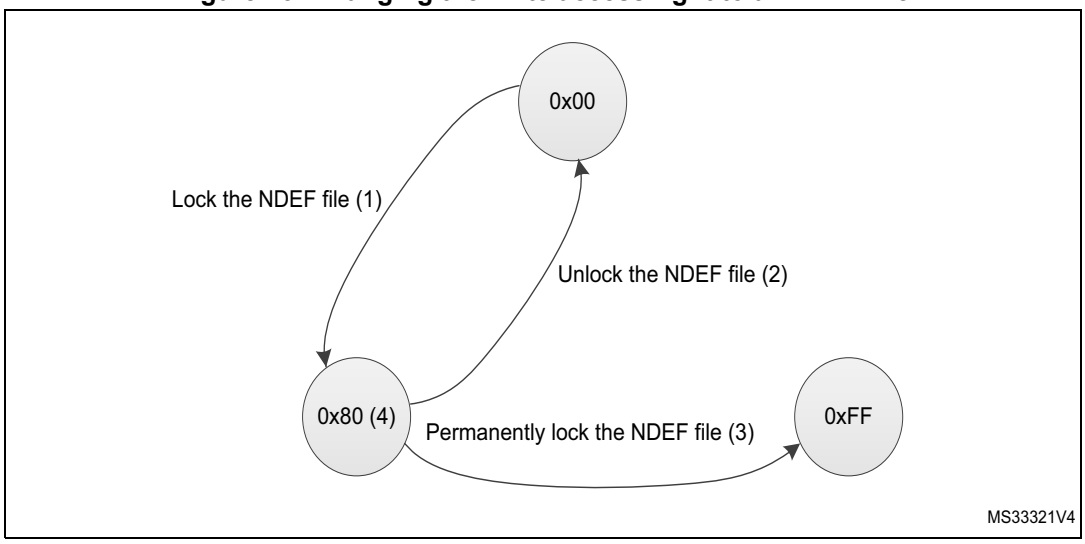


1. See the procedure to lock the read access (*Section 7.4: Locking an NDEF file*).
2. See the procedure to unlock the read access (*Section 7.5: Unlocking an NDEF file*).
3. See the procedure to permanently lock the read access.
4. Proprietary state, not defined by NFC Forum Type 4 Tag.

3.2.3 Changing the write access right to NDEF files

The state diagram on *Figure 13* shows how to change the write access right to an NDEF file.

Figure 13. Changing the write access right to an NDEF file



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

3.3 Access right life time

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

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

3.4 NDEF file passwords

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

Two NDEF file passwords are available for each NDEF file:

- Read password
- Write password

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

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