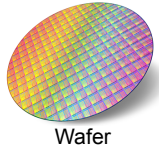# NFC Type 5 / RFID tag IC with 16-Kbit or 64-Kbit EEPROM and protection

Wafer

Features

Contactless interface

- Based on ISO/IEC 15693
- NFC Forum Type 5 tag certified by the NFC Forum
- Supports all ISO/IEC 15693 modulations, coding, subcarrier modes and data rates
- Custom Fast read access up to 53 Kbit/s
- Single and multiple block reads (Same for Extended commands)
- Single and multiple block writes (Same for Extended commands) (up to 4)
- Internal tuning capacitance: 28.5 pF
- Kill capability for privacy protection

Memory

- 16 KB or 64 Kbits of EEPROM
- RF interface accesses blocks of four bytes
- Typical write time: 5 ms for one block
- Data retention: 40 years
- Write cycles endurance:
  - 1 million write cycles at 25 °C
  - 600k write cycles at 85 °C

Data protection

- User memory: one to four configurable areas, protectable in read and/or write by three 64-bit passwords
- System configuration: protected in write by a
- 64-bit password

### Temperature range

- From - 40 to 85 °C

Product status link
ST25TV16K
ST25TV64K

DS11489 - Rev 8 - September 2018
For further information contact your local STMicroelectronics sales office.

www.st.com

1 Description

The ST25TV16K/64K device is a NFC and RFID Tag offering 16 Kbit or 64 Kbit of electrically erasable programmable memory (EEPROM). ST25TV16K/64K acts as a contactless memory accessed through a RF link, following ISO/IEC 15693 or NFC forum type 5 recommendations, and powered by the received carrier electromagnetic wave.

1.1 ST25TV16K/64K block diagram

Figure 1. **ST25TV16K/64K block diagram**
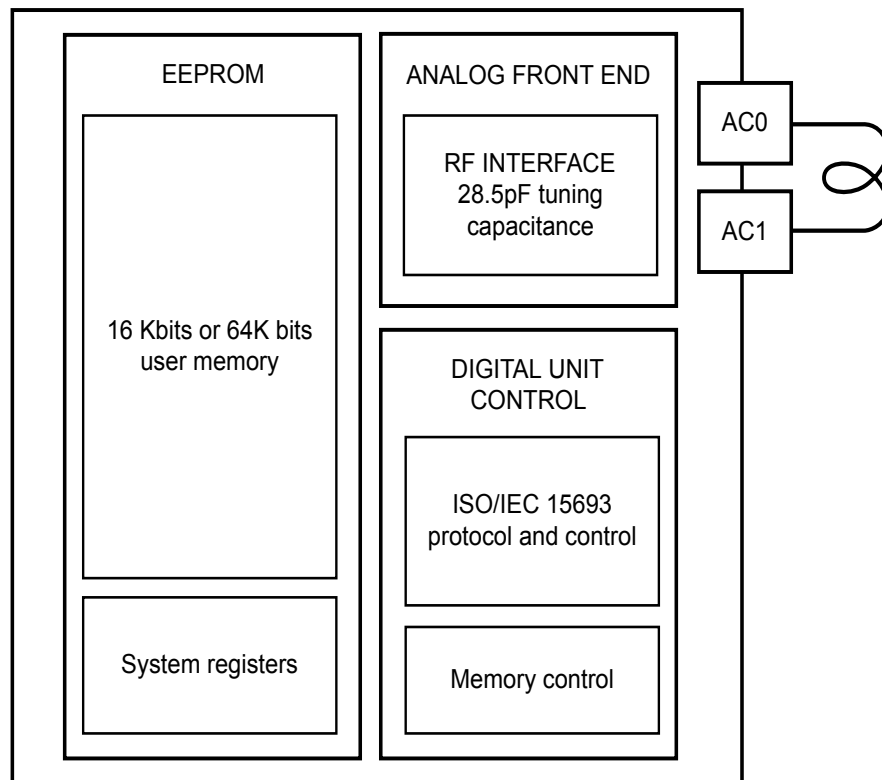
2 Signal descriptions

2.1 Antenna coil (AC0, AC1)

These inputs are used exclusively to connect the ST25TV16K/64K devices to an external coil. It is advised not to connect any other DC or AC path to AC0 or AC1.

When correctly tuned, the coil is used to power and access the device using the ISO/IEC 15693 and ISO 18000-3 mode 1 protocols.

3 Power management

3.1 Device set

To ensure a proper boot of the RF circuitry, the RF field must be turned ON without any modulation for a minimum period of time t_{RF_ON}. Before this time, ST25TV16K/64K ignores all received RF commands. (See Figure 2).

Figure 2. ST25TV16K/64K RF power-up sequence
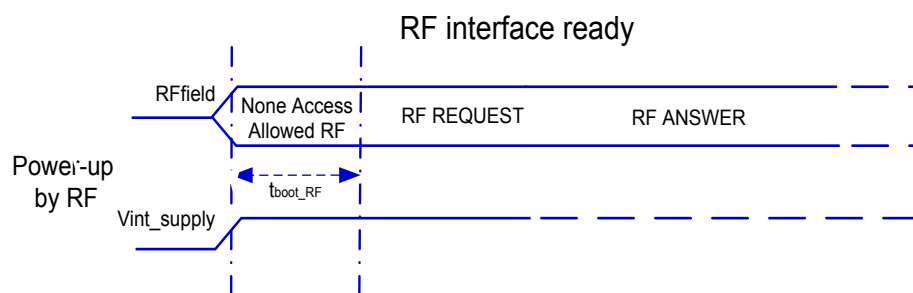
3.2 Device reset

To ensure a proper reset of the RF circuitry, the RF field must be turned off (100% modulation) for a minimum t_{RF_OFF} period of time.

The RF access can be definitely disabled by setting the appropriate value in the KILL register.

4 Memory management

4.1 Memory organization overview

The ST25TV16K/64K memory is divided in two main memory areas:
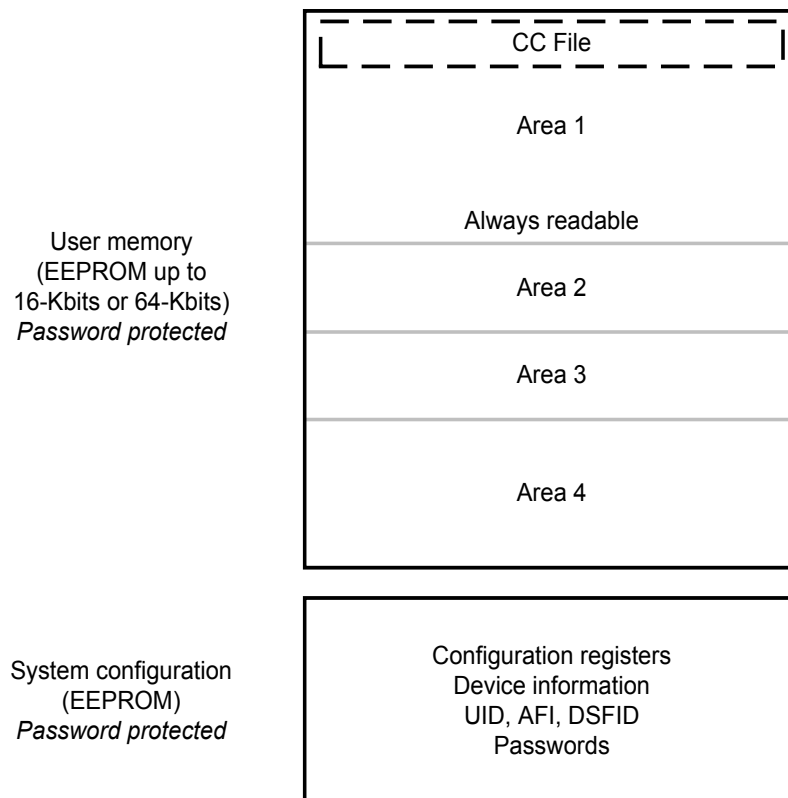
- User memory
- System configuration area

The ST25TV16K/64K user memory can be divided into 4 flexible user areas. Each area can be individually read - and/or - write-protected with one out of three specific 64-bit password.

The ST25TV16K/64K system configuration area contains registers to configure all ST25TV16K/64K features, which can be tuned by user. Its access is protected by a 64 bit configuration password.

This system configuration area also includes read only device information such as IC reference, memory size, as well as a 64-bit block that is used to store the 64-bit unique identifier (UID), and the AFI (default 00h) and DSFID (default 00h) registers. The UID is compliant with the ISO 15693 description, and its value is used during the anticollision sequence (Inventory). The UID value is written by ST on the production line. The AFI register stores the application family identifier. The DSFID register stores the data storage family identifier used in the anticollision algorithm.

The system configuration area includes four additional 64-bit blocks that store three RF user area access passwords and a RF configuration password.

Figure 3. Memory organization

4.2 User memory

User memory is addressed as blocks of 4 bytes, starting at address 0. RF Extended Read and Write commands can be used to address all ST25TV16K/64K memory blocks. Other read and write commands can only address up to block FFh.

All the blocks of the user memory are initialized to 00h in the factory.

Table 1. User memory as seen by RF shows how memory is seen from RF interface.

Table 1. User memory as seen by RF

RF command (block addressing)	User memory			
Read Single Block Read Multiple Blocks Fast Read Single Block Fast Read Multiple Blocks Write Single Block Write Multiple Blocks Ext. Read Single Block Ext. Read Multiple Blocks Fast Ext. Read Single Block Fast Ext. Read Multi. Blocks Ext. Write Single Block Ext. Write Multiple Blocks	RF block (00)00h			
	Byte 0003h	Byte 0002h	Byte 0001h	Byte 0000h
	RF block (00)01h			
	Byte 0007h	Byte 0006h	Byte 0005h	Byte 0004h
	RF block (00)02h			
	Byte 0011h	Byte 0010h	Byte 0009h	Byte 0008h
	....			
	RF block (00)FFh [1]			
	Byte 03FFh	Byte 03FEh	Byte 03FDh	Byte 03FCh
Ext. Read Single Block Ext. Read Multiple Blocks Fast Ext. Read Single Block Fast Ext. Read Multi. Blocks Ext. Write Single Block Ext. Write Multiple Blocks	RF block 0100h			
	Byte 0403h	Byte 0402h	Byte 0401h	Byte 0400h
	RF block 01FF [2]			
	Byte 07FFh	Byte 07FEh	Byte 07FDh	Byte 07FCh
	....			
	RF block 07FFh			
	Byte 1FFFh	Byte 1FFEh	Byte 1FFDh	Byte 1FFCh

1. Last block accessible with Read Single Block, Read Multiple Blocks, Fast Read Single Block, Fast Read Multiple Blocks, Write Single Block and Write Multiple Blocks RF commands.
2. Last block of user memory in ST25TV16K.

4.2.1 User memory areas

The user memory can be split into different areas, each one with a distinct access privilege.

RF read and write commands are legal only within a same zone:

- A multiple read or a multiple write command is not executed and returns the error code 0Fh if addresses cross the area borders.

Each user memory area is defined by its ending block address $ENDA_i$. The starting block address is defined by the end of the preceding area.

There are three $ENDA_i$ registers in the configuration system memory, used to define the end block addresses of Area 1, Area 2 and Area 3. The end of Area 4 is always the last block of memory and is not configurable.

Figure 4. ST25TV16K/64K user memory areas
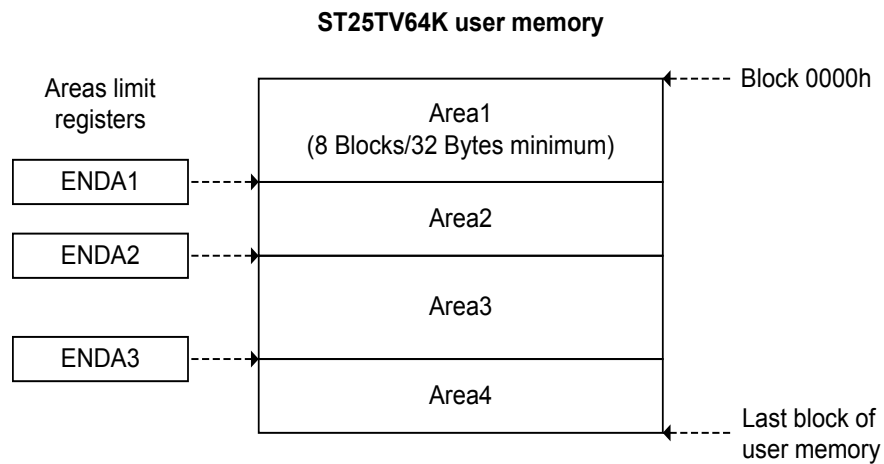
On factory delivery all $ENDA_i$ are set to maximum value, only Area1 exists and includes the full user memory.

A granularity of 8 Blocks (32 Bytes) is offered to code area ending points.

An area's end limit is coded as followed in $ENDA_i$ registers:

- Last block address of area = 8 x $ENDA_i$ + 7 => $ENDA_i$ = int(Last $Area_i$ block address / 8)
- As a consequence, ENDA1 = 0 means size of Area 1 is 8 blocks (32 Bytes).

Table 2. Maximum user memory block addresses and $ENDA_i$ value

Device	Last user memory block address seen by RF	Maximum $ENDA_i$ value
ST25TV16K	01FFh	3Fh
ST25TV64K	07FFh	FFh

Table 3. Areas and limit calculation from ENDA$_i$ registers

Area	Seen from RF interface
Area 1	Block 0000h … Block (ENDA1*8)+7
Area 2	Block (ENDA1+1)*8 … Block (ENDA2*8)+7
Area 3	Block (ENDA2+1)*8 … Block (ENDA3*8)+7
Area 4	Block (ENDA3+1)*8 … Last memory Block

Organization of user memory in areas have the following characteristics:

- At least one area exists (Area1), starting at Block address 0000h and finishing at ENDA1, with ENDA1 = ENDA2 = ENDA3 = End of user memory (factory setting).
- Two Areas could be defined by setting ENDA1 < ENDA2 = ENDA3 = End of user memory.
- Three Areas may be defined by setting ENDA1 < ENDA2 < ENDA3 = End of user memory.
- A maximum of four areas may be defined by setting ENDA1 < ENDA2 < ENDA3 < End of user memory.
- Area 1 specificities
    - Start of Area1 is always Block address 0000h.
    - Area1 minimum size is 8 Blocks (32 Bytes) when ENDA1 = 00h.
    - Area1 is always readable.
- The last area always finishes on the last user memory Block address (ENDA4 doesn't exist).
- All areas are contiguous: end of Area(n) + one Block address is always start of Area(n+1).

Area size programming

RF user must first open the configuration security session to write ENDAi registers.

When programming an ENDAi register, the following rule must be respected:

- ENDAi-1 < ENDAi ≤ ENDAi+1 = FFh (End of user memory).

This means that prior to programming any ENDAi register, its successor (ENDAi+1) must first be programmed to the last Block of memory:

- Successful ENDA3 programming condition: ENDA2 < ENDA3 ≤ End of user memory.
- Successful ENDA2 programming condition: ENDA1 < ENDA2 ≤ ENDA3 = End of user memory.
- Successful ENDA1 programming condition: ENDA1 ≤ ENDA2 = ENDA 3 = End of user memory.

If this rule is not respected, an error 0Fh is returned, and programming is not done.

In order to respect this rule, the following procedure is recommended when programming Areas size (even for changing only one Area size):

1. Ends of Areas 3 and 2 must first be set to the end of memory while respecting the following order:
    a. If ENDA3 ≠ end of user memory, then set ENDA3 = end of memory; else, do not write ENDA3.
    b. If ENDA2 ≠ end of user memory, then set ENDA2 = end of memory; else, do not write ENDA2.
2. Then, desired area limits can be set respecting the following order:
    a. Set new ENDA1 value.
    b. Set new ENDA2 value, with ENDA2 > ENDA1

    c.   Set new ENDA3 value, with ENDA3 > ENDA2

Example of successive user memory area setting (for a ST25TV64K):

1. Initial state, 2 Areas are defined:
    a. ENDA1 = 10h (Last block of Area 1: (10h x 8) + 7 = 0087h)
    b. ENDA2 = FFh (Last block of Area 2: (FFh x 8) + 7 = 07FFh)
    c. ENDA3 = FFh (No Area 3)
        ◦ Area 1 from Block 0000h to 0087h (136 Blocks)
        ◦ Area 2 from Block 0088h to 07FFh (1912 Blocks)
        ◦ There is no Area 3.
        ◦ There is no Area 4.

2. Split of user memory in four areas:
    a. ENDA3 is not updated as it is already set to end of memory.
    b. ENDA2 is not updated as it is already set to end of memory.
    c. Set ENDA1 = 3Fh (Last block of Area 1: (3Fh x 8) + 7 = 01FFh)
    d. Set ENDA2 = 5Fh (Last block of Area 1: (5Fh x 8) + 7 = 02FFh)
    e. Set ENDA3 = BFh (Last block of Area 1: (BFh x 8) + 7 = 05FFh)
        ◦ Area1 from Block 0000h to 01FFh (512 Blocks)
        ◦ Area2 from Block 0200h to 02FFh (256 Blocks)
        ◦ Area3 from Block 0300h to 05FFh (768 Blocks)
        ◦ Area4 from Block 0600h to 07FFh (512 Blocks).

3. Return to a split in two equal areas:
    a. Set ENDA3 = FFh
    b. Set ENDA2 = FFh
    c. Set ENDA1 = 7Fh (Last block of Area 1: (7Fh x 8) + 7 = 03FFh)
        ◦ Area1 from Block 0000h to 03FFh (1024 Blocks)
        ◦ Area2 from Block 0400h to 07FFh (1024 Blocks)
        ◦ There is no Area3.
        ◦ There is no Area4.

Programming ENDA3 to FFh in step 2.a would have resulted in into an error, since rule ENDAi-1 < ENDAi would not been respected (ENDA2 = ENDA3 in that case).

Registers for user memory area configuration

Table 4. ENDA1

-	Command	Read Configuration (cmd code A0h) @05h
		Write Configuration (cmd code A1h) @05h
	Type	R always, W if configuration security session is open and configuration not locked
Bit	Name	Function	Factory Value
b7-b0	ENDA1	End Area 1 = 8*ENDA1+7 when expressed in blocks (RF)	ST25TV16K 3Fh
			ST25TV64K FFh

Note: *Refer to Table 7. System configuration memory map for the ENDA1 register.*

Table 5. ENDA2

-	Command	Read Configuration (cmd code A0h) @07h
		Write Configuration (cmd code A1h) @07h
	Type	R always, W if configuration security session is open and configuration not locked
Bit	Name	Function	Factory Value
b7-b0	ENDA2	End Area 2 = 8 x ENDA2 + 7 when expressed in blocks (RF)	ST25TV16K 3Fh
			ST25TV64K FFh

Note: *Refer to Table 7. System configuration memory map for the ENDA2 register.*

Table 6. ENDA3

-	Command	Read Configuration (cmd code A0h) @09h
		Write Configuration (cmd code A1h) @09h
	Type	R always, W if configuration security session is open and configuration not locked
Bit	Name	Function	Factory Value
b7-b0	ENDA3	End Area 3 = 8 x ENDA3 + 7 when expressed in blocks (RF)	ST25TV16K 3Fh
			ST25TV64K FFh

Note: *Refer to Table 7. System configuration memory map for the ENDA3 register.*

4.3   System configuration area

In addition to EEPROM user memory, ST25TV16K/64K includes a set of registers located in the system configuration area memory (EEPROM nonvolatile registers). Those registers are set during device configuration (i.e.: area extension), or by the application (i.e.: area protection). Registers content is read during the boot sequence and define basic ST25TV16K/64K behavior.

The registers located in the system configuration area can be accessed via dedicated Read Configuration and Write Configuration commands, with a pointer acting as the register address.

The configuration security session must first be open, by presenting a valid configuration password, to grant write access to system configuration registers.

Table 7. System configuration memory map shows the complete map of the system configuration area.

Table 7. **System configuration memory map**

RF access		Static Register	
Address	Type	Name	Function
03h	RW [1]	Table 8. KILL	Tag kill
04h	RW [1]	Table 9. A1SS	Area1 access protection
05h	RW [1]	Table 4. ENDA1	Area 1 ending point
06h	RW [1]	Table 10. A2SS	Area2 access protection
07h	RW [1]	Table 5. ENDA2	Area 2 ending point
08h	RW [1]	Table 11. A3SS	Area3 access protection
09h	RW [1]	Table 6. ENDA3	Area 3 ending point
0Ah	RW [1]	Table 12. A4SS	Area4 access protection
N/A	RW [2] [3]	Table 13. LOCK_CCFILE	Blocks 0 and 1 RF Write protection
0Fh	RW [1]	Table 14. LOCK_CFG	Protect Write to system configuration registers
N/A	WO [4]	Table 20. LOCK_DSFID	DSFID lock status
NA	WO [5]	Table 21. LOCK_AFI	AFI lock status
N/A	RW [4]	Table 22. DSFID	DSFID value
N/A	RW [5]	Table 23. AFI	AFI value
N/A	RO	Table 24. MEM_SIZE	Memory size value in blocks, 2 bytes
	RO	Table 25. BLK_SIZE	Block size value in bytes
N/A	RO	Table 26. IC_REF	IC reference value
NA	RO	Table 27. UID	Unique identifier, 8 bytes
N/A	WO [6]	Table 15. PWD_0	Configuration security session password, 8 bytes
N/A	WO [6]	Table 16. PWD_1	User security session password 1, 8 bytes
N/A	WO [6]	Table 17. PWD_2	User security session password 2, 8 bytes
N/A	WO [6]	Table 18. PWD_3	User security session password 3, 8 bytes

1. *Write access is granted if RF configuration security session is open and configuration is not locked (LOCK_CFG register equals to 0).*
2. *Write access to bit 0 if Block 00h is not already locked and to bit 1 if Block 01h is not already locked.*
3. *LOCK_CCFILE content is only readable through reading the Block Security Status of blocks 00h and 001h (see Section 5.2.3 User memory protection)*
4. *Write access if DSFID is not locked*
5. *Write access if AFI is not locked.*
6. *Write access only if corresponding security session is open.*

5 ST25TV16K/64K specific features

ST25TV16K/64K offers the data protection feature, both user memory and system configuration, and a kill mode.

Those features can be programmed by setting registers of the ST25TV16K/64K. ST25TV16K/64K can be partially customized using configuration registers located in the EEPROM system area.

These registers are dedicated to:

- Data Memory organization and protection ENDA$_i$, AiSS, LOCK_CCFILE.
- Kill mode, KILL
- The device's structure LOCK_CFG

A set of additional registers allows to identify and customize the product (DSFID, AFI, IC_REF, etc.).

Dedicated commands Read Configuration and Write Configuration must be used to access the configuration registers. Update is only possible when the access right has been granted by presenting the configuration password (PWD_0), and if the system configuration was not previously locked (LOCK_CFG=1).

After any valid write access to the configuration registers, the new configuration is immediately applied.

5.1 Kill feature

5.1.1 Kill register

Table 8. KILL

RF	Command	Read Configuration (cmd code A0h) @03h		
		Write Configuration (cmd code A1h) @03h		
	Type	R always, W if RF configuration security session is open and configuration not locked		
Bit	Name	Function		Factory Value
b0	KILL_ERROR	0: RF commands executed 1: ST25TV16K/64K is killed but still answers commands with error 0Fh		0b
b1	KILL_MUTE	0: RF communication enabled 1: ST25TV16K/64K is killed and doesn't answer to any command		0b
b7-b2	RFU	-		000000b

Note: *Refer to Table 7. System configuration memory map for the KILL register.*

5.1.2 Kill mode description

KILL register allow the user to definitely kill the ST25TV16K/64K tag.

KILL register is composed of two bits (see Table 8. KILL): KILL_ERROR and KILL_MUTE. For a normal usage of RF interface, bits KILL_MUTE and KILL_ERROR must be set to 0.

Three working modes are offered for ST25TV16K/64K:

- Kill mute mode:
  – When KILL_MUTE is set to 1, ST25TV16K/64K is killed. It can't be read or write and stay mute to any request. Kill mute mode is definitive.
- Kill error mode:
  – When KILL_MUTE is set to 0 and KILL_ERROR is set to 1, RF commands are interpreted but not executed. In case of a valid command, ST25TV16K/64K responds after t1 with the error code 0Fh. Inventory and Stay Quiet commands are not answered. Kill error mode is definitive
- Normal mode:

– In normal usage, KILL_MUTE and KILL_ERROR are set to 0, ST25TV16K/64K processes the request and respond accordingly.

5.2 Data Protection

ST25TV16K/64K provides a special data protection mechanism based on passwords that unlock security sessions.

User memory can be protected for read and/or write access and system configuration can be protected from write access.

5.2.1 Data protection registers

Table 9. A1SS

RF	Command	Read Configuration (cmd code A0h) @04h	
		Write Configuration (cmd code A1h) @04h	
	Type	R always, W if configuration security session is open and configuration not locked	
Bit	Name	Function	Factory Value
b1-b0	PWD_CTRL_A1	00: Area 1 user security session can't be open by password 01: Area 1 user security session is open by PWD_1 10: Area 1 user security session is open by PWD_2 11: Area 1 user security session is open by PWD_3	00b
b3-b2	RW_PROTECTION_A1	00: Area 1 access: Read always allowed / Write always allowed 01: Area 1 access: Read always allowed, Write allowed if user security session is open 10: Area 1 access: Read always allowed, Write allowed if user security session is open 11: Area 1 access: Read always allowed, Write always forbidden	00b
b7-b4	RFU	-	0000b

Note: Refer to Table 7. System configuration memory map for the A1SS register.

Table 10. A2SS

-	Command	Read Configuration (cmd code A0h) @06h		
		Write Configuration (cmd code A1h) @06h		
	Type	R always, W if configuration security session is open and configuration not locked		
Bit	Name	Function		Factory Value
b1-b0	PWD_CTRL_A2	00: Area 2 user security session can't be open by password 01: Area 2 user security session is open by PWD_1 10: Area 2 user security session is open by PWD_2 11: Area 2 user security session is open by PWD_3		00b
b3-b2	RW_PROTECTION_A2	00: Area 2 access: Read always allowed, Write always allowed 01: Area 2 access: Read always allowed, Write allowed if user security session is open 10: Area 2 access: Read allowed if user security session is open, Write allowed if RF user security session is open 11: Area 2 access: Read allowed if user security session is open, Write always forbidden.		00b
b7-b4	RFU	-		0000b

Note: *Refer to Table 7. System configuration memory map for the A2SS register.*

Table 11. A3SS

-	Command	Read Configuration (cmd code A0h) @08h		
		Write Configuration (cmd code A1h) @08h		
	Type	R always, W if RF configuration security session is open and configuration not locked		
Bit	Name	Function		Factory Value
b1-b0	PWD_CTRL_A3	00: Area 3 user security session can't be open by password 01: Area 3 user security session is open by PWD_1 10: Area 3 user security session is open by PWD_2 11: Area 3 user security session is open by PWD_3		00b
b3-b2	RW_PROTECTION_A3	00: Area 3 access: Read always allowed / Write always allowed 01: Area 3 access: Read always allowed, Write allowed if user security session is open 10: Area 3 access: Read allowed if user security session is open, Write allowed if user security session is open 11: Area 3 access: Read allowed if user security session is open, Write always forbidden.		00b
b7-b4	RFU	-		0000b

Note: *Refer to Table 7. System configuration memory map for the A3SS register.*

Table 12. A4SS

RF	Command	Read Configuration (cmd code A0h) @0Ah	
		Write Configuration (cmd code A1h) @0Ah	
	Type	R always, W if configuration security session is open and configuration not locked	
Bit	Name	Function	Factory Value
b1-b0	PWD_CTRL_A4	00: Area 4 user security session can't be open by password 01: Area 4 user security session is open by PWD_1 10: Area 4 user security session is open by PWD_2 11: Area 4 user security session is open by PWD_3	00b
b3-b2	RW_PROTECTION_A4	00: Area 4 access: Read always allowed, Write always allowed 01: Area 4 access: Read always allowed, Write allowed if user security session is open 10: Area 4 access: Read allowed if user security session is open, Write allowed if user security session is open 11: Area 4 access: Read allowed if user security session is open, Write always forbidden	00b
b7-b4	RFU	-	0000b

Note: *Refer to Table 7. System configuration memory map for the A4SS register.*

Table 13. LOCK_CCFILE

-	Command	Lock Block (cmd code 22h) @00h/01h	
		Ext Lock Block (cmd code 32h) @00h/01h	
		Read Block (cmd code 20h) @00h/01h	
		Fast Read Block[1] (cmd code C0h) @00h/01h	
		Ext Read Block[1] (cmd code 30h) @00h/01h	
		Fast Ext Read Block[1] (cmd code C4h) @00h/01h	
		Read Multi Block[1] (cmd code 23h) @00h/01h	
		Ext Read Multi Block[1] (cmd code 33h) @00h/01h	
		Fast Read Multi Block[1] (cmd code C3h) @00h/01h	
		Fast Ext Read Multi Block[1] (cmd code C5h) @00h/01h	
		Get Multi Block SS (cmd code 2Ch) @00h/01h	
		Ext Get Multi Block SS (cmd code 3Ch) @00h/01h	
	Type	R always b0: W if Block 00h is not already locked, b1: W if Block 01h is not already locked.	
Bit	Name	Function	Factory Value
b0	LCKBCK0	0: Block @ 00h is not Write locked 1: Block @ 00h is Write locked	0b
b1	LCKBCK1	0: Block @ 01h is not Write locked 1: Block @ 01h is Write locked	0b
b7-b2	RFU	-	000000b

1.   *With option flag set to 1.*

Note: *Refer to Table 7. System configuration memory map for the LOCK_CCFILE register.*

Table 14. LOCK_CFG

-	Command	Read Configuration (cmd code A0h) @0Fh
		Write Configuration (cmd code A1h) @0Fh
	Type	R always, W if configuration security session is open and configuration not locked
Bit	Name	Function	Factory Value
b0	LCK_CFG	0: Configuration is unlocked	0b
		1: Configuration is locked	
b7-b1	RFU	-	0000000b

Note: Refer to *Table 7. System configuration memory map* for the LOCK_CFG register.

Table 15. PWD_0

-	Command	Present Password (cmd code B3h)
		Write Password (cmd code B1h)
	Type	WO if configuration security session is open
Bit	Name	Function	Factory Value
b7-b0		Byte 0 (LSB) of password for configuration security session	00h
b7-b0		Byte 1 of password for configuration security session	00h
b7-b0		Byte 2 of password for configuration security session	00h
b7-b0		Byte 3 of password for configuration security session	00h
b7-b0	PWD_0	Byte 4 of password for configuration security session	00h
b7-b0		Byte 5 of password for configuration security session	00h
b7-b0		Byte 6 of password for configuration security session	00h
b7-b0		Byte 7 (MSB) of password for configuration security session	00h

Note: Refer to *Table 7. System configuration memory map* for the PWD_0 register.

Table 16. PWD_1

-	Command	Present Password (cmd code B3h)
		Write Password (cmd code B1h)
	Type	WO if configuration security session is open with password 1
Bit	Name	Function	Factory Value
b7-b0		Byte 0 (LSB) of password 1 for user security session	00h
b7-b0		Byte 1 of password 1 for user security session	00h
b7-b0		Byte 2 of password 1 for user security session	00h
b7-b0		Byte 3 of password 1 for user security session	00h
b7-b0	RF_PWD_1	Byte 4 of password 1 for user security session	00h
b7-b0		Byte 5 of password 1 for user security session	00h
b7-b0		Byte 6 of password 1 for user security session	00h
b7-b0		Byte 7 (MSB) of password 1 for user security session	00h

Note: Refer to *Table 7. System configuration memory map* for the PWD_1 register.

Table 17. PWD_2

-	Command	Present Password (cmd code B3h)		
		Write Password (cmd code B1h)		
	Type	WO if user security session is open with password 2		
Bit	Name	Function		Factory Value
b7-b0	PWD_2	Byte 0 (LSB) of password 2 for user security session		00h
b7-b0		Byte 1 of password 2 for user security session		00h
b7-b0		Byte 2 of password 2 for user security session		00h
b7-b0		Byte 3 of password 2 for user security session		00h
b7-b0		Byte 4 of password 2 for user security session		00h
b7-b0		Byte 5 of password 2 for user security session		00h
b7-b0		Byte 6 of password 2 for user security session		00h
b7-b0		Byte 7 (MSB) of password 2 for user security session		00h

Note: *Refer to Table 7. System configuration memory map for the PWD_2 register.*

Table 18. PWD_3

-	Command	Present Password (cmd code B3h)		
		Write Password (cmd code B1h)		
	Type	WO if user security session is open with password 3		
Bit	Name	Function		Factory Value
b7-b0	PWD_3	Byte 0 (LSB) of password 3for user security session		00h
b7-b0		Byte 1 of password 3 for user security session		00h
b7-b0		Byte 2 of password 3 for user security session		00h
b7-b0		Byte 3 of password 3 for user security session		00h
b7-b0		Byte 4 of password 3 for user security session		00h
b7-b0		Byte 5 of password 3 for user security session		00h
b7-b0		Byte 6 of password 3 for user security session		00h
b7-b0		Byte 7 (MSB) of password 3 for user security session		00h

Note: *Refer to Table 7. System configuration memory map for the PWD_3 register.*

5.2.2 Passwords and security sessions

ST25TV16K/64K provides protection of user memory and system configuration registers. user and host can access those protected data by opening security sessions with the help of passwords. Access rights is more restricted when security sessions are closed, and less restricted when security sessions are open.

There is two types of security sessions, as shown in Table 19. Security session type:

Table 19. Security session type

Security session	Open by presenting	Right granted when security session is open, and until it is closed
user	password 1, 2 or 3 (PWD_1, PWD_2, PWD_3)	user access to protected user memory as defined in A$_i$SS registers user write access to password 1, 2 or 3
configuration	password 0 (PWD_0)	user write access to configuration registers user write access to password 0

1. *Password number must be the same as the one selected for protection.*
2. *Write access to the password number corresponding to the password number presented.*

All passwords are 64-bits long, and default factory passwords value is 0000000000000000h.

The ST25TV16K/64K passwords management is organized around dedicated set of commands to access the dedicated registers in system configuration area.

The dedicated password commands are:

- Write Password command (code B1h): see Section 6.4.28 Write Password.
- Present Password command (code B3h): see Section 6.4.29 Present Password.

User possible actions for security sessions are:

- **Open user security session**: Present Password command, with password number 1, 2 or 3 and the valid corresponding password
- **Write password**: Present Password command, with password number (0, 1, 2 or 3) and the current valid corresponding password. Then Write Password command, with same password number (0, 1, 2 or 3) and the new corresponding password.
- **Close user security session**: Present Password command, with a different password number than the one used to open session or any wrong password. Or remove tag from RF field (POR).
- Presenting a password with an invalid password number doesn't close the session.
- **Open configuration security session**: Present Password command, with password number 0 and the valid password 0.
- **Close configuration security session**: Present Password command, with a password number different than 0, or password number 0 and wrong password 0. Or remove tag from field (POR).
- Presenting a password with an invalid password number doesn't close the session.

Opening any new security session (user or configuration) automatically close the previously open one (even if it fails).

Caution: To make the application more robust, it is recommended to use addressed or selected mode during write password operations to get the traceability of which tags/UID have been programmed

Figure 5. **Security sessions management**
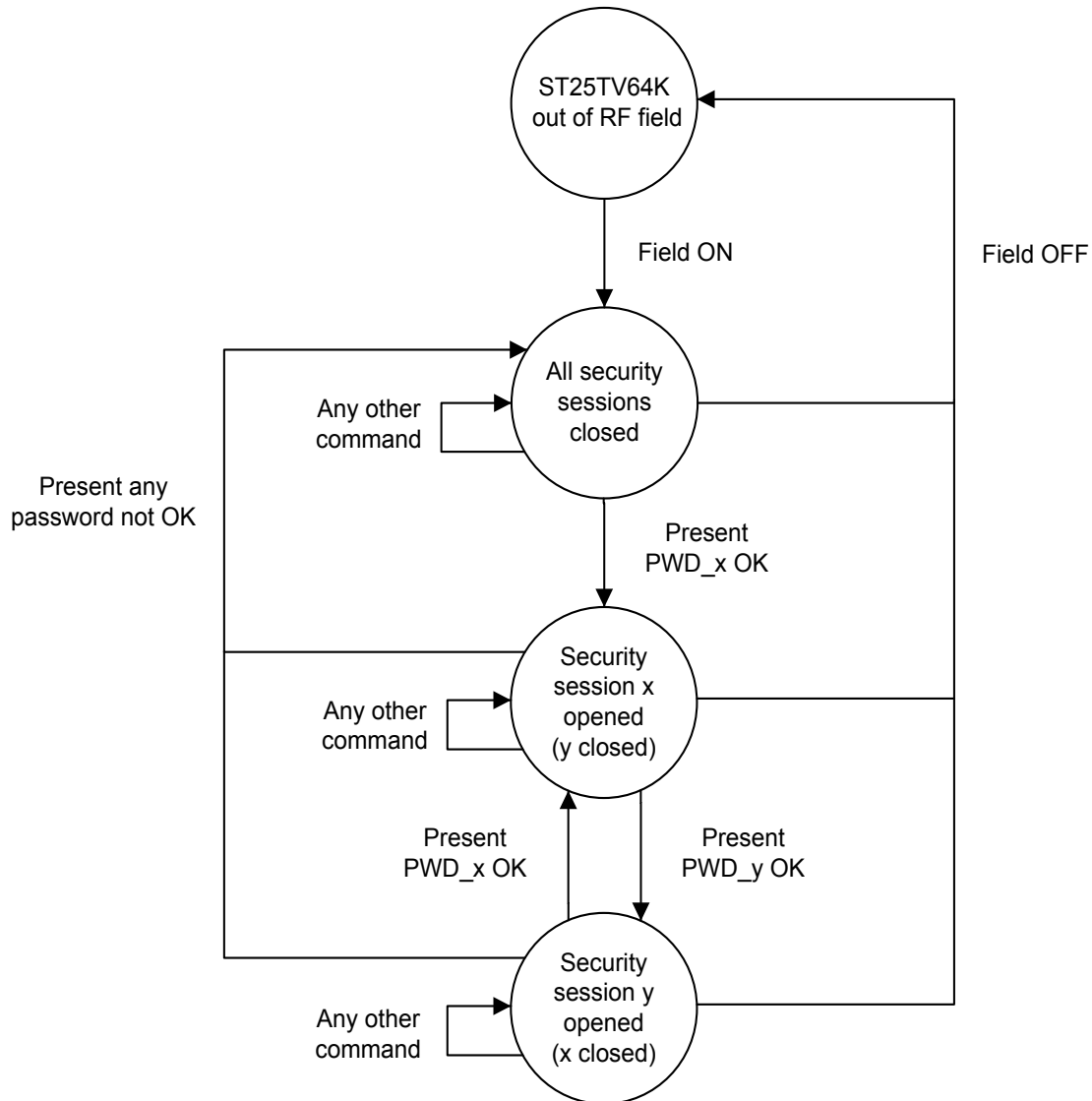
5.2.3 User memory protection

On factory delivery, areas are not protected.

Each area can be individually protected in read and/or write access.

Area 1 is always readable.

Furthermore, blocks 0 and 1 can be independently write locked.

Each memory area of the ST25TV16K/64K can be individually protected by one out of three available passwords (password 1, 2 or 3), and each area can also have individual Read/Write access conditions.

For each area, an AiSS register is used to:

- Select the password that unlock the user security session for this area
- Select the protection against read and write operations for this area

(See Table 9. A1SS, Table 10. A2SS, Table 11. A3SS and Table 12. A4SS for details about available read and write protections).

Note: *Setting 00b in PWD_CTRL_A$_i$ field means that user security session cannot be open by any password for the corresponding area.*

When updating AiSS registers, the new protection value is effective immediately after the register write completion.

- blocks 0 and 1 are exceptions to this protection mechanism:
    - Blocks 0 and 1 can be individually write locked by issuing a (Ext) Lock Single Block command. Once locked, they cannot be unlock. LOCK_CCFILE register is automatically updated when using (Ext) Lock Single Block command.
    - User needs no password to lock blocks 0 and/or 1.
    - Locking blocks 0 and/or 1 is possible even if the configuration is locked (LOCK_CFG=1).
    - Locking blocks 0 and/or 1 is possible even if the area is write locked.
    - Unlocking area1 (through A1SS register) does not unlock blocks 0 and 1 if they have been locked though (Ext) Lock Block command.
    - Once locked, the user cannot unlock blocks 0 and/or 1.

Note: *When areas size are modified (ENDAi registers), AiSS registers are not modified.*

Retrieve the security status of a user memory block or byte

User can read a block security status by issuing following commands:

- (Ext) Get Multiple Blocks Security Status command
- (Ext) (Fast) Read Single Block with option flag set to 1
- (Ext) (Fast) Read Multiple Blocks with option flag set to 1

ST25TV16K/64K responds with a Block security status containing a Lock_bit flag as specified in ISO 15693 standard. This lock_bit flag is set to 1 if block is locked against write.

Lock_bit flag value may vary if corresponding user security session is open or closed.

5.2.4 System memory protection

By default, the system memory is write protected.

To enable write access to system configuration registers, user must open the configuration security session (by presenting a valid password 0) and system configuration must not be locked (LOCK_CFG=00h).

By default, user can read all system configuration registers, except all passwords, LOCK_CCFILE, LOCK_DSFID and LOCK_AFI.

Configuration lock:

- Write access to system configuration registers can be locked by writing 01h in the LOCK_CFG register.
- User cannot unlock system configuration if LOCK_CFG=01h, even after opening configuration security session (Lock is definitive).
- When system configuration is locked (LOCK_CFG=01h), it is still possible to change passwords (0 to 3).

Device identification registers:

- AFI and DFSID registers can be independently locked by user, issuing respectively a Lock AFI and a Lock DSFID command. Lock is definitive: once locked, AFI and DSFID registers cannot be unlocked (either by RF or I2C). System configuration locking mechanism (LOCK_CFG=01h) does not lock AFI and DSFID registers.
- Other device identification registers (MEM_SIZE, BLK_SIZE, IC_REF, UID) are read only registers.

5.3 Device Parameter Registers

Table 20. LOCK_DSFID

Bit	Command	Lock DSFID (cmd code 2Ah)		Factory Value
	Type	WO if DSFID not locked		
	Name	Function		Factory Value
b0	LOCK_DSFID	0: DSFID is not locked 1: DSFID is locked		0b
b7-b1	RFU	-		0000000b

Note: *Refer to Table 7. System configuration memory map for the LOCK_DSFID register.*

Table 21. LOCK_AFI

Bit	Command	Lock AFI (cmd code 28h)		Factory Value
	Type	WO if AFI not locked		
	Name	Function		Factory Value
b0	LOCK_AFI	0: AFI is not locked 1: AFI is locked		0b
b7-b1	RFU	-		0000000b

Note: *Refer to Table 7. System configuration memory map for the LOCK_AFI register.*

Table 22. DSFID

Bit	Command	Inventory (cmd code 01h)		Factory Value
		Get System Info (cmd code 2Bh)		
		Ext Get System Info (cmd code 3Bh)		
		Write DSFID (cmd code 28h)		
	Type	R always, W if DSFID not locked		
	Name	Function		Factory Value
b7-b0	DSFID	ISO/IEC 15693 Data Storage Format Identifier		00h

Note: *Refer to Table 7. System configuration memory map for the DSFID register.*

Table 23. AFI

Bit	Command	Inventory (cmd code 01h)	
		Get System Info (cmd code 2Bh)	
		Ext Get System Info (cmd code 3Bh)	
		Write AFI (cmd code 27h)	
	Type	R always, W if AFI not locked	
	Name	Function	Factory Value
b7-b0	AFI	ISO/IEC 15693 Application Family Identifier	00h

Note: Refer to *Table 7. System configuration memory map* for the AFI register.

Table 24. MEM_SIZE

Bit	Command	Ext Get System Info (cmd code 3Bh)	
	Type	RO	
	Name	Function	Factory Value
b7-b0	MEM_SIZE	LSB byte of the memory size expressed in blocks	FFh
b7-b0		MSB byte of the memory size expressed in blocks	01h 07h

Note: Refer to *Table 7. System configuration memory map* for the MEM_SIZE register.

Table 25. BLK_SIZE

Bit	Command	Ext Get System Info (cmd code 3Bh)	
	Type	RO	
	Name	Function	Factory Value
b7-b0	BLK_SIZE	user memory block size	03h

Note: Refer to *Table 7. System configuration memory map* for the BLK_SIZE register.

Table 26. IC_REF

Bit	Command	Get System Info (cmd code 2Bh)	
		Ext Get System Info (cmd code 3Bh)	
	Type	RO	
	Name	Function	Factory Value
b7-b0	IC_REF	ISO/IEC 15693 IC Reference	48h

Note: Refer to *Table 7. System configuration memory map* for the IC_REF register.

Table 27. UID

Bit	Command	Inventory (cmd code 01h)		
		Get System Info (cmd code 2Bh)		
		Ext Get System Info (cmd code 3Bh)		
	Type	RO		
	Name	Function		Factory Value
b7-b0	UID	ISO/IEC 15693 UID byte 0 (LSB)		IC manufacturer serial number
b7-b0		ISO/IEC 15693 UID byte 1		
b7-b0		ISO/IEC 15693 UID byte 2		
b7-b0		ISO/IEC 15693 UID byte 3		
b7-b0		ISO/IEC 15693 UID byte 4		
b7-b0		ISO/IEC 15693 UID byte 5: ST Product code		48h
b7-b0		ISO/IEC 15693 UID byte 6: IC Mfg code		02h
b7-b0		ISO/IEC 15693 UID byte 7 (MSB)		E0h

Note: Refer to *Table 7. System configuration memory map* for the UID register.

6 RF Operations

Contactless exchanges are performed as specified by ISO/IEC 15693 or NFC Forum Type 5. The ST25TV16K/64K communicates via the 13.56 MHz carrier electromagnetic wave on which incoming data are demodulated from the received signal amplitude modulation (ASK: amplitude shift keying). The received ASK wave is 10% or 100% modulated with a data rate of 1.6 Kbit/s using the 1/256 pulse coding mode or a data rate of 26 Kbit/s using the 1/4 pulse coding mode.

Outgoing data are generated by the ST25TV16K/64K load variation using Manchester coding with one or two subcarrier frequencies at 423 kHz and 484 kHz. Data are transferred from the ST25TV16K/64K at 6.6 Kbit/s in low data rate mode and 26 Kbit/s in high data rate mode. The ST25TV16K/64K supports the 53 Kbit/s in high data rate mode in one sub-carrier frequency at 423 kHz.

The ST25TV16K/64K follows ISO/IEC 15693 or NFC Forum Type 5 recommendation for radio-frequency power and signal interface and for anticollision and transmission protocol.

6.1 RF communication

6.1.1 Access to a ISO/IEC 15693 device

The dialog between the "reader" and the ST25TV16K/64K takes place as follows:

These operations use the power transfer and communication signal interface described below (see Power transfer, Frequency and Operating field). This technique is called RTF (Reader talk first).

- Activation of the ST25TV16K/64K by the operating field of the reader,
- Transmission of a command by the reader (ST25TV16K/64K detects carrier amplitude modulation)
- Transmission of a response by the ST25TV16K/64K(ST25TV16K/64K modulates is load clocked at subcarrier rate)

Operating field

The ST25TV16K/64K operates continuously between the minimum and maximum values of the electromagnetic field H defined in Table 146. RF characteristics. The Reader has to generate a field within these limits.

Power transfer

Power is transferred to the ST25TV16K/64K by radio frequency at 13.56 MHz via coupling antennas in the ST25TV16K/64K and the Reader. The operating field of the reader is transformed on the ST25TV16K/64K antenna to an AC voltage which is rectified, filtered and internally regulated. During communications, the amplitude modulation (ASK) on this received signal is demodulated by the ASK demodulator.

Frequency

The ISO 15693 standard defines the carrier frequency (f_C) of the operating field as

13.56 MHz ± 7 kHz.

6.2 RF protocol description

6.2.1 Protocol description

The transmission protocol (or simply "the protocol") defines the mechanism used to exchange instructions and data between the VCD (Vicinity Coupling Device) and the VICC (Vicinity integrated circuit card) in both directions. It is based on the concept of "VCD talks first". The ST25TV16K/64K acts as the VICC.

This means that a ST25TV16K/64K does not start transmitting unless it has received and properly decoded an instruction sent by the VCD. The protocol is based on an exchange of:

- a request from the VCD to the ST25TV16K/64K,
- a response from the ST25TV16K/64K to the VCD.

Each request and each response are contained in a frame. The frames are delimited by a Start of Frame (SOF) and End of Frame (EOF).

The protocol is bit-oriented. The number of bits transmitted in a frame is a multiple of eight (8), that is an integer number of bytes.

A single-byte field is transmitted least significant bit (LSBit) first. A multiple-byte field is transmitted least significant byte (LSByte) first and each byte is transmitted least significant bit (LSBit) first.

Figure 6. ST25TV16K/64K protocol timing
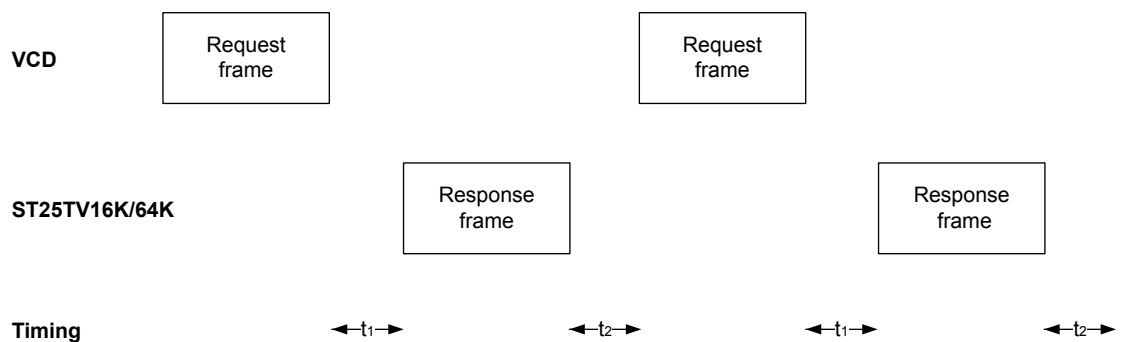
6.2.2 ST25TV16K/64K states referring to protocol

The ST25TV16K/64K can be in one of four states:

- Power-off
- Ready
- Quiet
- Selected

Transitions between these states are specified in Figure 7. ST25TV16K/64K state transition diagram and Table 28. response depending on Request_flags.

Power-off state

The ST25TV16K/64K is in the power-off state when it does not receive enough energy from the VCD.

Ready state

The ST25TV16K/64K is in the Ready state when it receives enough energy from the VCD. When in the Ready state, the ST25TV16K/64K answers any request where the Select_flag is not set.

Quiet state

When in the Quiet state, the ST25TV16K/64K answers any request with the Address_flag set, except for Inventory requests.

Selected state

In the Selected state, the ST25TV16K/64K answers any request in all modes (see Section 6.2.3 Modes):

- Request in Select mode with the Select_flag set
- Request in Addressed mode if the UID matches
- Request in Non-Addressed mode as it is the mode for general requests

Table 28. **response depending on Request_flags**

Flags	Address_flag		Select_flag	
	1	0	1	0
	Addressed	Non addressed	Selected	Non selected
ST25TV16K/64K in Ready or Selected state (Devices in Quiet state do not answer)	-	X	-	X
ST25TV16K/64K in Selected state	-	X	X	-
ST25TV16K/64K in Ready, Quiet or Selected state (the device which matches the UID)	X	-	-	X
Error (03h) or no response (command dependent)	X	-	X	-

Figure 7. **ST25TV16K/64K state transition diagram**
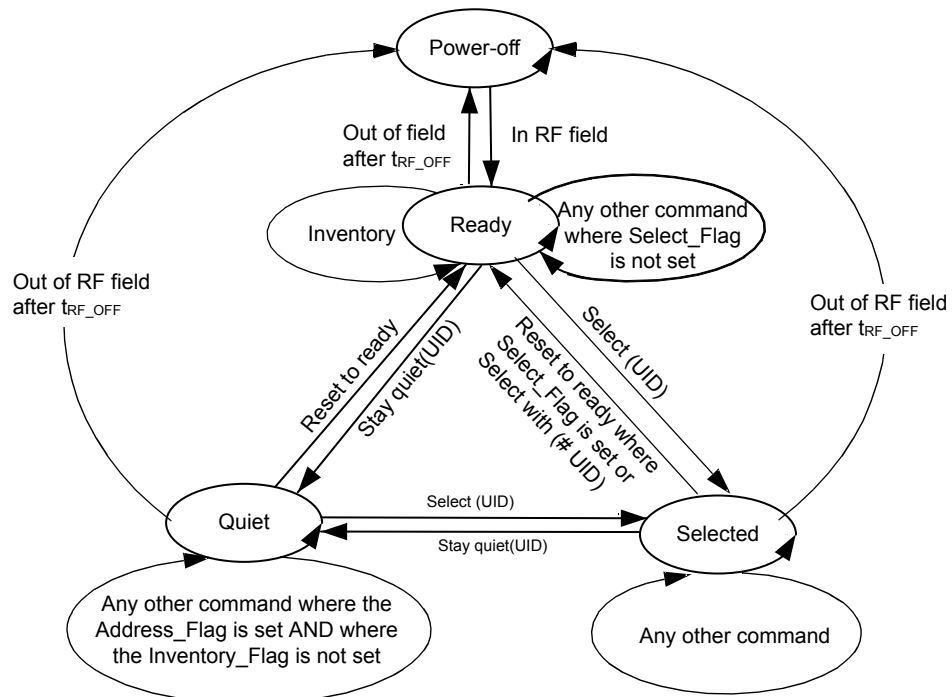
1. The ST25TV16K/64K returns to the Power Off state if the tag is out of the field for at least t_{RF_OFF}.

The intention of the state transition method is that only one ST25TV16K/64K should be in the Selected state at a time.

When the Select_flag is set to 1, the request shall NOT contain a unique ID.

When the address_flag is set to 0, the request shall NOT contain a unique ID.

6.2.3 Modes

The term "mode" refers to the mechanism used in a request to specify the set of ST25TV16K/64K devices that shall execute the request.

Addressed mode

When the Address_flag is set to 1 (Addressed mode), the request contains the Unique ID (UID) of the addressed ST25TV16K/64K.

Any ST25TV16K/64K that receives a request with the Address_flag set to 1 compares the received Unique ID to its own. If it matches, then the ST25TV16K/64K executes the request (if possible) and returns a response to the VCD as specified in the command description.

If the UID does not match, then it remains silent.

Non-addressed mode (general request)

When the Address_flag is cleared to 0 (Non-Addressed mode), the request does not contain a Unique ID.

Select mode

When the Select_flag is set to 1 (Select mode), the request does not contain a unique ID. The ST25TV16K/64K in the Selected state that receives a request with the Select_flag set to 1 executes it and returns a response to the VCD as specified in the command description.

Only the ST25TV16K/64K in the Selected state answers a request where the Select_flag is set to 1.

The system design ensures that only one ST25TV16K/64K can be in the Select state at a time.

6.2.4 Request format

The request consists of:

- an SOF
- flags
- a command code
- parameters and data
- a CRC
- an EOF

Table 29. General request format

SOF	Request_flags	Command code	Parameters	Data	2 byte CRC	EOF

6.2.5 Request flags

In a request, the "flags" field specifies the actions to be performed by the ST25TV16K/64K and whether corresponding fields are present or not.

The flags field consists of eight bits. Bit 3 (Inventory_flag) of the request flag defines the contents of the four MSBs (bits 5 to 8). When bit 3 is reset (0), bits 5 to 8 define the ST25TV16K/64K selection criteria. When bit 3 is set (1), bits 5 to 8 define the ST25TV16K/64K Inventory parameters.

Table 30. Definition of request flags 1 to 4

Bit No	Flag	Level	Description
Bit 1	Subcarrier_flag [1]	0	A single subcarrier frequency is used by the ST25TV16K/64K
		1	Two subcarriers are used by the ST25TV16K/64K
Bit 2	Data_rate_flag [2]	0	Low data rate is used
		1	High data rate is used
Bit 3	Inventory_flag	0	The meaning of flags 5 to 8 is described in Table 31. Request flags 5 to 8 when inventory_flag, Bit 3 = 0
		1	The meaning of flags 5 to 8 is described in Table 32. Request flags 5 to 8 when inventory_flag, Bit 3 = 1
Bit 4	Protocol_extension_flag	0	No Protocol format extension
		1	Protocol format extension. Reserved for future use.

1. *Subcarrier_flag refers to the ST25TV16K/64K-to-VCD communication.*
2. *Data_rate_flag refers to the ST25TV16K/64K-to-VCD communication.*

Table 31. Request flags 5 to 8 when inventory_flag, Bit 3 = 0

Bit nb	Flag	Level	Description
Bit 5	Select flag [1]	0	The request is executed by any ST25TV16K/64K according to the setting of Address_flag
		1	The request is executed only by the ST25TV16K/64K in Selected state
Bit 6	Address flag	0	The request is not addressed. UID field is not present. The request is executed by all ST25TV16K/64Ks.
		1	The request is addressed. UID field is present. The request is executed only by the ST25TV16K/64K whose UID matches the UID specified in the request.
Bit 7	Option flag	0	Option not activated.
		1	Option activated.
Bit 8	RFU	0	-

1. If the Select_flag is set to 1, the Address_flag is set to 0 and the UID field is not present in the request.

Table 32. Request flags 5 to 8 when inventory_flag, Bit 3 = 1

Bit nb	Flag	Level	Description
Bit 5	AFI flag	0	AFI field is not present
		1	AFI field is present
Bit 6	Nb_slots flag	0	16 slots
		1	1 slot
Bit 7	Option flag	0	-
Bit 8	RFU	0	-

6.2.6 Response format

The response consists of:

- an SOF
- flags
- parameters and data
- a CRC
- an EOF

Table 33. General response format

SOF	Response_flags	Parameters	Data	2 byte CRC	EOF

6.2.7 Response flags

In a response, the flags indicate how actions have been performed by the ST25TV16K/64K and whether corresponding fields are present or not. The response flags consist of eight bits.

Table 34. Definitions of response flags 1 to 8

Bit Nb	Flag	Level	Description
Bit 1	Error_flag	0	No error
		1	Error detected. Error code is in the "Error" field.
Bit 2	RFU	0	-
Bit 3	RFU	0	-
Bit 4	Extension flag	0	No extension
Bit 5	RFU	0	-
Bit 6	RFU	0	-
Bit 7	RFU	0	-
Bit 8	RFU	0	-

6.2.8 Response and error code

If the Error_flag is set by the ST25TV16K/64K in the response, the Error code field is present and provides information about the error that occurred.

Error codes not specified in Table 35. Response error code definition are reserved for future use.

Table 35. Response error code definition

Error code	Meaning
01h	Command is not supported.
02h	Command is not recognized (format error).
03h	The option is not supported.
0Fh	Error with no information given.
10h	The specified block is not available.
11h	The specified block is already locked and thus cannot be locked again.
12h	The specified block is locked and its contents cannot be changed.
13h	The specified block was not successfully programmed.
14h	The specified block was not successfully locked.
15h	The specified block is protected in read.
No response	It might indicate illegal programming

6.3 Timing definition

t_1: ST25TV16K/64K response delay

Upon detection of the rising edge of the EOF received from the VCD, the ST25TV16K/64K waits for a t_{1nom} time before transmitting its response to a VCD request or switching to the next slot during an inventory process. Values of t_1 are given in Table 36. Timing values.

t_2: VCD new request delay

t_2 is the time after which the VCD may send an EOF to switch to the next slot when one or more ST25TV16K/64K responses have been received during an Inventory command. It starts from the reception of the EOF from the ST25TV16K/64Ks.

The EOF sent by the VCD may be either 10% or 100% modulated regardless of the modulation index used for transmitting the VCD request to the ST25TV16K/64K.

t_2 is also the time after which the VCD may send a new request to the ST25TV16K/64K, as described in Figure 6. ST25TV16K/64K protocol timing.

Values of t_2 are given in Table 36. Timing values.

t_3: VCD new request delay when no response is received from the ST25TV16K/64K

t_3 is the time after which the VCD may send an EOF to switch to the next slot when no ST25TV16K/64K response has been received.

The EOF sent by the VCD may be either 10% or 100% modulated regardless of the modulation index used for transmitting the VCD request to the ST25TV16K/64K.

From the time the VCD has generated the rising edge of an EOF:

- If this EOF is 100% modulated, the VCD waits for a time at least equal to t_{3min} for 100% modulation before sending a new EOF.
- If this EOF is 10% modulated, the VCD waits for a time at least equal to t_{3min} for 10% modulation before sending a new EOF.

Table 36. Timing values

	Minimum (min) values		Nominal (nom) values	Maximum (max) values
	100% modulation	**10% modulation**		
t_1		4320 / f_c = 318.6 µs	4352 / f_c = 320.9 µs	4384 / f_c = 323.3 µs [1]
t_2		4192 / f_c = 309.2 µs	No t_{nom}	No t_{max}
t_3	t_{1max}[2] + t_{SOF} [3]	t_{1max} [2]+ t_{NRT}[4] + t_{2min}	No t_{nom}	No t_{max}

1. *VCD request will not be interpreted during the first milliseconds following the field rising.*

2. *t_{1max} does not apply for write-alike requests. Timing conditions for write-alike requests are defined in the command description.*

3. *t_{SOF} is the time taken by the ST25TV16K/64K to transmit an SOF to the VCD. t_{SOF} depends on the current data rate: High data rate or Low data rate.*

4. *t_{NRT} is the nominal response time of the ST25TV16K/64K. t_{NRT} depends on VICC to ST25TV16K/64K data rate and subcarrier modulation mode.*

Note: *The tolerance of specific timing is ± 32/f_C.*

6.4 RF Commands

6.4.1 RF command code list

The ST25TV16K/64K supports the following legacy and extended RF command set:

- **Inventory**, used to perform the anticollision sequence.
- **Stay Quiet**, used to put the ST25TV16K/64K in quiet mode, where it does not respond to any inventory command.
- **Select**, used to select the ST25TV16K/64K. After this command, the ST25TV16K/64K processes all Read/Write commands with Select_flag set.
- **Reset To Ready**, used to put the ST25TV16K/64K in the ready state.
- **Read Single Block** and **Extended Read Single Block**, used to output the 32 bit of the selected block and its locking status.
- **Write Single Block** and **Extended Write Single Block**, used to write and verify the new content for an update of a 32 bit block, provided that it is not in a locked memory area.
- **Read Multiple Blocks** and **Extended Read Multiple Block**, used to read the selected blocks in an unique area, and send back their value.
- Write Multiple Blocks and **Extended Write Multiple Block**, used to write and verify the new content for an update of up to 4 blocks located in the same memory area, which was not previously locked for writing.
- Write AFI, used to write the 8-bit value in the AFI register.
- **Lock AFI**, used to lock the AFI register.
- **Write DSFID**, used to write the 8-bit value in the DSFID register.
- **Lock DSFID**, used to lock the DSFID register.
- Get System information, used to provide the standard system information values.
- Extended Get System Information, used to provide the extended system information values.
- Write Password, used to update the 64 bit of the selected areas or configuration password, but only after presenting the current one.
- **Lock Block** and **Extended Lock block**, used to write the CC file blocks security status bits (Protect the CC File content against writing).
- **Present Password**, enables the user to present a password to open a security session.
- **Fast Read Single Block** and **Fast Extended Read Single Block**, used to output the 32 bits of the selected block and its locking status at doubled data rate.
- **Fast Read Multiple Blocks** and **Fast Extended Read Multiple Blocks**, used to read the selected blocks in a single area and send back their value at doubled data rate.
- Read Configuration, used to read static configuration registers.
- **Write Configuration**, used to write static configuration registers.
- Get multiple block security status, and **Extended Get multiple block security** status used to send the security status of the selected block.

6.4.2 Command codes list

The ST25TV16K/64K supports the commands described in this section. Their codes are given in Table 37. Command codes.

Table 37. Command codes

Command code standard	Function	Command code custom	Function
01h	Section 6.4.4 Inventory	A0h	Section 6.4.26 Read Configuration
02h	Section 6.4.5 Stay Quiet	A1h	Section 6.4.27 Write Configuration
20h	Section 6.4.6 Read Single Block	B1h	Section 6.4.28 Write Password
21h	Section 6.4.8 Write Single Block	B3h	Section 6.4.29 Present Password
22h	Section 6.4.10 Lock block	C0h	Section 6.4.30 Fast Read Single Block
23h	Section 6.4.12 Read Multiple Blocks	C3h	Section 6.4.32 Fast Read Multiple Blocks
24h	Section 6.4.14 Write Multiple Blocks	C4h	Section 6.4.31 Fast Extended Read Single Block
25h	Section 6.4.16 Select	C5h	Section 6.4.33 Fast Extended Read Multiple Block
26h	Section 6.4.17 Reset to Ready		
27h	Section 6.4.18 Write AFI		
28h	Section 6.4.19 Lock AFI		
29h	Section 6.4.20 Write DSFID		
2Ah	Section 6.4.21 Lock DSFID		
2Bh	Section 6.4.22 Get System Info		
2Ch	Section 6.4.24 Get Multiple Block Security Status		
30h	Section 6.4.7 Extended Read Single Block		
31h	Section 6.4.9 Extended Write Single Block		
32h	Section 6.4.11 Extended Lock block		
33h	Section 6.4.13 Extended Read Multiple Blocks		
34h	Section 6.4.15 Extended Write Multiple Blocks		
3Bh	Section 6.4.23 Extended Get System Info		
3Ch	Section 6.4.25 Extended Get Multiple Block Security Status		

6.4.3 General Command Rules

In case of a valid command, the following paragraphs will describe the expected behavior for each command.

But in case of an invalid command, in a general manner, the ST25TV16K/64K will behave as follows:

1. If flag usage is incorrect, the error code 03h will be issued only if the right UID is used in the command, otherwise no response will be issued.

2. The error code 02h will be issued if the custom command is used with the manufacturer code different from the ST one

6.4.4 Inventory

Upon receiving the Inventory request, the ST25TV16K/64K runs the anticollision sequence. The Inventory_flag is set to 1. The meaning of flags 5 to 8 is shown in Table 32. Request flags 5 to 8 when inventory_flag, Bit 3 = 1.

The request contains:
- the flags
- the Inventory command code (001)
- the AFI if the AFI flag is set
- the mask length
- the mask value if mask length is different from 0
- the CRC

The ST25TV16K/64K does not generate any answer in case of error.

Table 38. Inventory request format

Request SOF	Request_flags	Inventory	Optional AFI	Mask length	Mask value	CRC16	Request EOF
-	8 bits	01h	8 bits	8 bits	0 - 64 bits	16 bits	-

The response contains:
- the flags
- the Unique ID

Table 39. Inventory response format

Response SOF	Response_flags	DSFID	UID	CRC16	Response EOF
-	8 bits	8 bits	64 bits	16 bits	-

During an Inventory process, if the VCD does not receive an RF ST25TV16K/64K response, it waits for a time t_3 before sending an EOF to switch to the next slot. t_3 starts from the rising edge of the request EOF sent by the VCD.
- If the VCD sends a 100% modulated EOF, the minimum value of t_3 is:
- $t_3min = 4384/f_C$ (323.3µs) + t_{SOF}
- If the VCD sends a 10% modulated EOF, the minimum value of t_3 is:
- $t_3min = 4384/f_C$ (323.3µs) + t_{NRT} + t_{2min}

where:
- t_{SOF} is the time required by the ST25TV16K/64K to transmit an SOF to the VCD,
- t_{NRT} is the nominal response time of the ST25TV16K/64K.

t_{NRT} and t_{SOF} are dependent on the ST25TV16K/64K-to-VCD data rate and subcarrier modulation mode.

Note: *In case of error, no response is sent by ST25TV16K/64K.*

6.4.5 Stay Quiet

On receiving the Stay Quiet command, the ST25TV16K/64K enters the Quiet state if no error occurs, and does NOT send back a response. There is NO response to the Stay Quiet command even if an error occurs.

The Option_flag is not supported. The Inventory_flag must be set to 0.

When in the Quiet state:
- the ST25TV16K/64K does not process any request if the Inventory_flag is set,
- the ST25TV16K/64K processes any Addressed request.

The ST25TV16K/64K exits the Quiet state when:
- it is reset (power off),
- receiving a Select request. It then goes to the Selected state,
- receiving a Reset to Ready request. It then goes to the Ready state.

Table 40. Stay Quiet request format

Request SOF	Request flags	Stay Quiet	UID	CRC16	Request EOF
-	8 bits	02h	64 bits	16 bits	-

The Stay Quiet command must always be executed in Addressed mode (Select_flag is reset to 0 and Address_flag is set to 1).

Figure 8. Stay Quiet frame exchange between VCD and ST25TV16K/64K
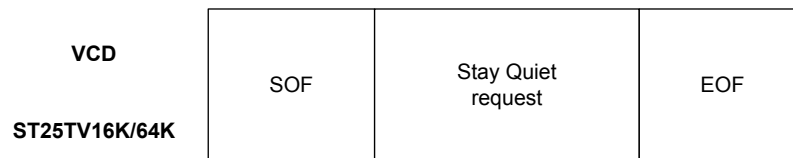
6.4.6 Read Single Block

On receiving the Read Single Block command, the ST25TV16K/64K reads the requested block and sends back its 32-bit value in the response. The Option_flag is supported, when set response include the Block Security Status.

The Inventory_flag must be set to 0.

Block number is coded on 1 Byte and only first 256 blocks of ST25TV16K/64K can be addressed using this command.

Table 41. Read Single Block request format

Request SOF	Request_flags	Read Single Block	UID [1]	Block number	CRC16	Request EOF
-	8 bits	20h	64 bits	8 bits	16 bits	-

1. This field is optional.

Request parameters:
- Request flags
- UID (optional)
- Block number (from LSB byte to MSB byte)

Table 42. Read Single Block response format when Error_flag is NOT set

Response SOF	Response_flags	Block security status [1]	Data	CRC16	Response EOF
-	8 bits	8 bits	32 bits	16 bits	-

1. This field is optional.

Response parameters:
- Block security status if Option_flag is set (see Table 43. Block security status)

- Four bytes of block data

Table 43. Block security status

b$_7$	b$_6$	b$_5$	b$_4$	b$_3$	b$_2$	b$_1$	b$_0$
Reserved for future use. All at 0.							0: Current block not locked 1: Current block locked

Table 44. Read Single Block response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

- Error code as Error_flag is set
  – 03h: command option not supported
  – 0Fh: error with no information
  – 10h: the specified block is not available
  – 15h: the specified block is read-protected

Figure 9. Read Single Block frame exchange between VCD and ST25TV16K/64K
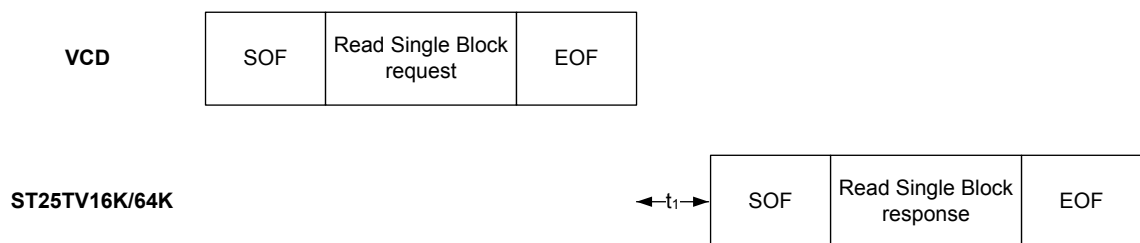
6.4.7 Extended Read Single Block

On receiving the Extended Read Single Block command, the ST25TV16K/64K reads the requested block and sends back its 32-bit value in the response.

The Inventory_flag must be set to 0.

When the Option_flag is set, the response includes the Block Security Status.

Block number is coded on 2 Bytes so all memory blocks of ST25TV16K/64K can be addressed using this command.

Table 45. Extended Read Single Block request format

Request SOF	Request_flags	Extended Read Single Block	UID [1]	Block number	CRC16	Request EOF
-	8 bits	30h	64 bits	16 bits	16 bits	-

1. This field is optional.

Request parameters:

- Request flags

- UID (optional)
- Block number (from LSB byte to MSB byte)

Table 46. Extended Read Single Block response format when Error_flag is NOT set

Response SOF	Response_flags	Block security status [1]	Data	CRC16	Response EOF
-	8 bits	8 bits	32 bits	16 bits	-

1. This field is optional.

Response parameters:
- Block security status if Option_flag is set (see Table 43. Block security status)
- Four bytes of block data

Table 47. Block security status

b7	b6	b5	b4	b3	b2	b1	b0
Reserved for future use. All at 0.							0: Current block not locked 1: Current block locked

Table 48. Extended Read Single Block response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:
- Error code as Error_flag is set
  – 03h: command option not supported or no response
  – 0Fh: error with no information
  – 10h: the specified block is not available
  – 15h: the specified block is read-protected

Figure 10. Extended Read Single Block frame exchange between VCD and ST25TV16K/64K
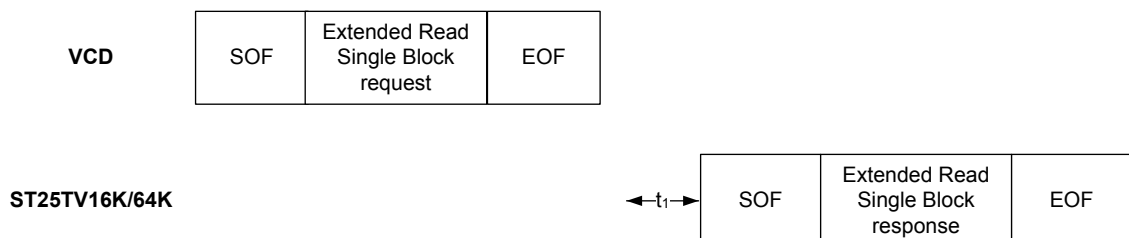
6.4.8 Write Single Block

On receiving the Write Single Block command, the ST25TV16K/64K writes the data contained in the request to the targeted block and reports whether the write operation was successful in the response. When the Option_flag is set, wait for EOF to respond.

The Inventory_flag must be set to 0.

During the RF write cycle W_t, there should be no modulation (neither 100% nor 10%), otherwise the ST25TV16K/64K may not program correctly the data into the memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Block number is coded on 1 Byte and only first 256 blocks of ST25TV16K/64K can be addressed using this command.

Table 49. Write Single Block request format

Request SOF	Request_flags	Write Single Block	UID [1]	Block number	Data	CRC16	Request EOF
-	8 bits	21h	64 bits	8 bits	32 bits	16 bits	-

1. This field is optional.

Request parameters:
- Request flags
- UID (optional)
- Block number
- Data

Table 50. Write Single Block response format when Error_flag is NOT set

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:
- No parameter. The response is sent back after the writing cycle.

Table 51. Write Single Block response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:
- Error code as Error_flag is set[1]
  - 03h: command option not supported
  - 0Fh: error with no information given
  - 10h: the specified block is not available
  - 12h: the specified block is locked or protected and its contents cannot be changed
  - 13h: the specified block was not successfully programmed

1. For more details, see Figure 3. Memory organization

Figure 11. Write Single Block frame exchange between VCD and ST25TV16K/64K
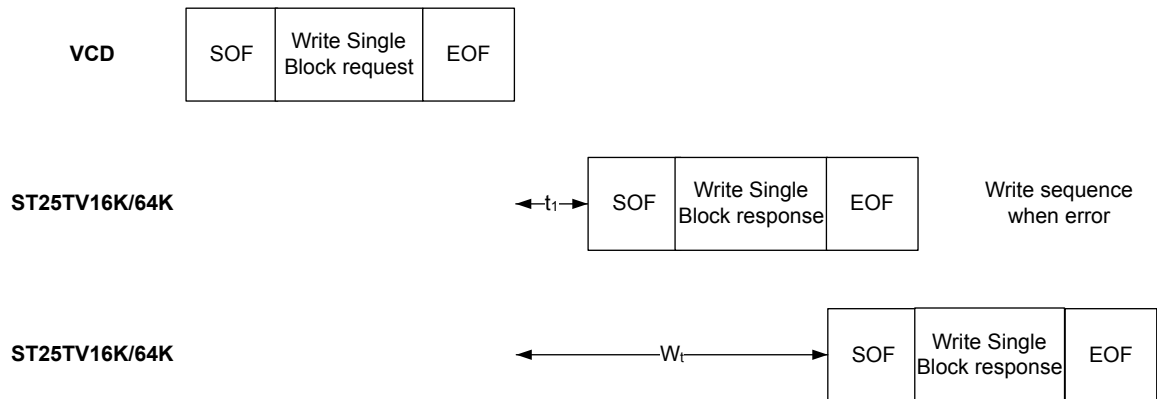
6.4.9 Extended Write Single Block

On receiving the Extended Write Single command, the ST25TV16K/64K writes the data contained in the request to the targeted block and reports whether the write operation was successful in the response. When the Option_flag is set, wait for EOF to respond.

The Inventory_flag must be set to 0.

During the RF write cycle W_t, there should be no modulation (neither 100% nor 10%), otherwise the ST25TV16K/64K may not program correctly the data into the memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Block number is coded on 1 Byte and only first 256 blocks of ST25TV16K/64K can be addressed using this command.

Table 52. Extended Write Single request format

Request SOF	Request_flags	Extended Write Single Block	UID [1]	Block number	Data	CRC16	Request EOF
-	8 bits	31h	64 bits	16 bits	32 bits	16 bits	-

1. This field is optional.

Request parameters:
- Request flags
- UID (optional)
- Block number (from LSB byte to MSB byte)
- Data (from LSB byte to MSB byte)

Table 53. Extended Write Single response format when Error_flag is NOT set

| Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:
- No parameter. The response is sent back after the writing cycle.

Table 54. Extended Write Single response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

- Error code as Error_flag is set:
    – 03h: command option not supported
    – 0Fh: error with no information given
    – 10h: the specified block is not available
    – 12h: the specified block is locked and its contents cannot be changed
    – 13h: the specified block was not successfully programmed

Figure 12. Extended Write Single frame exchange between VCD and ST25TV16K/64K
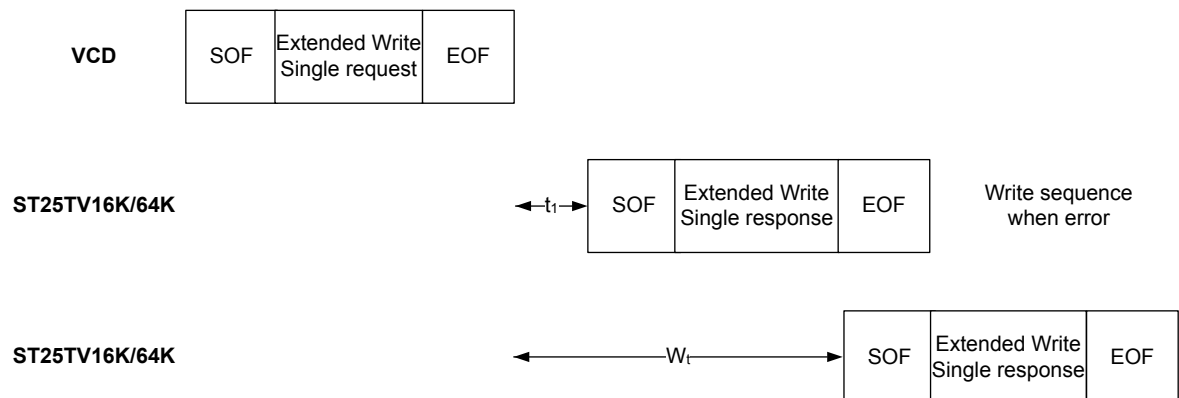
6.4.10   Lock block

On receiving the Lock block request, the ST25TV16K/64K locks the single block value permanently and protects its content against new writing.

This command is only applicable for the blocks 0 and 1 which may include a CC file.

For a global protection of a area, update accordingly the RFAiSS bits in the system area. The Option_flag is supported, when set wait for EOF to respond.

The Inventory_flag must be set to 0.

During the RF write cycle W_t, there should be no modulation (neither 100% nor 10%), otherwise the ST25TV16K/64K may not lock correctly the single block value in memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Table 55. Lock block request format

Request SOF	Request_flags	Lock block	UID [1]	block number	CRC16	Request EOF
-	8 bits	22h	64 bits	8 bits	16 bits	-

1. *This field is optional.*

Request parameter:

- Request Flags
- UID (optional)

- Block number (only value 00h or 01h) are allowed to protect the CCfile in case of NDEF usage.

Table 56. Lock block response format when Error_flag is NOT set

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:

- No parameter

Table 57. Lock single block response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

- Error code as Error_flag is set
  - 03h: command option not supported
  - 10h: block not available
  - 11h: the specified block is already locked and thus cannot be locked again
  - 14h: the specified block was not successfully locked

Figure 13. Lock single block frame exchange between VCD and ST25TV16K/64K
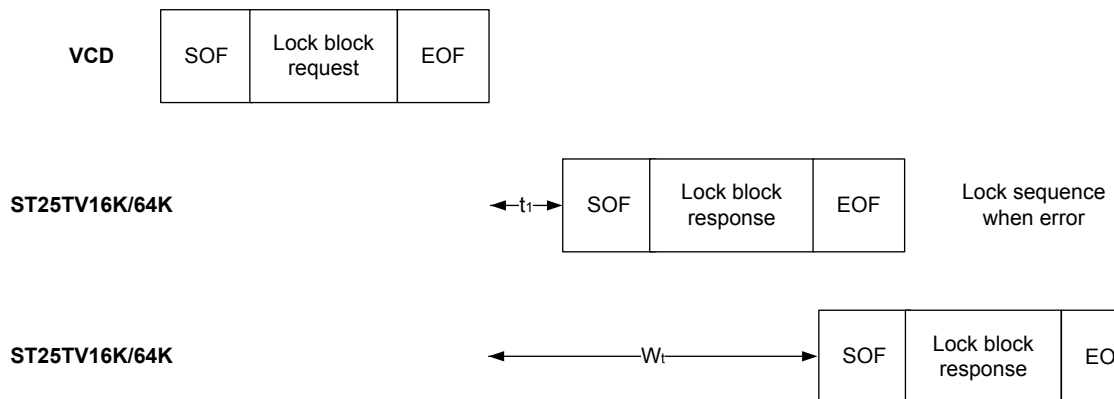
6.4.11 Extended Lock block

On receiving the extended Lock block request, the ST25TV16K/64K locks the single block value permanently and protects its content against new writing.

This command is only applicable for the blocks 0 and 1 which may include a CC file.

For a global protection of a area, update accordingly the AiSS bits in the system area. When the Option_flag is set, wait for EOF to respond.

The Inventory_flag must be set to 0.

During the RF write cycle W_t, there should be no modulation (neither 100% nor 10%), otherwise the ST25TV16K/64K may not lock correctly the single block value in memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Table 58. Extended Lock block request format

Request SOF	Request_flags	Extended Lock block	UID [1]	block number	CRC16	Request EOF
-	8 bits	32h	64 bits	16 bits	16 bits	-

1. *This field is optional.*

Request parameter:

• Request Flags

• UID (optional)

• Only block number 0 and 1 are allowed to protect the CCFile in case of NDEF (from LSB byte to MSB byte).

Table 59. Extended Lock block response format when Error_flag is NOT set

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:

• No parameter

Table 60. Extended Lock block response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

• Error code as Error_flag is set

– 03h: command option not supported

– 10h: block not available

– 11h: the specified block is already locked and thus cannot be locked again

– 14h: the specified block was not successfully locked

Figure 14. Extended Lock block frame exchange between VCD and ST25TV16K/64K
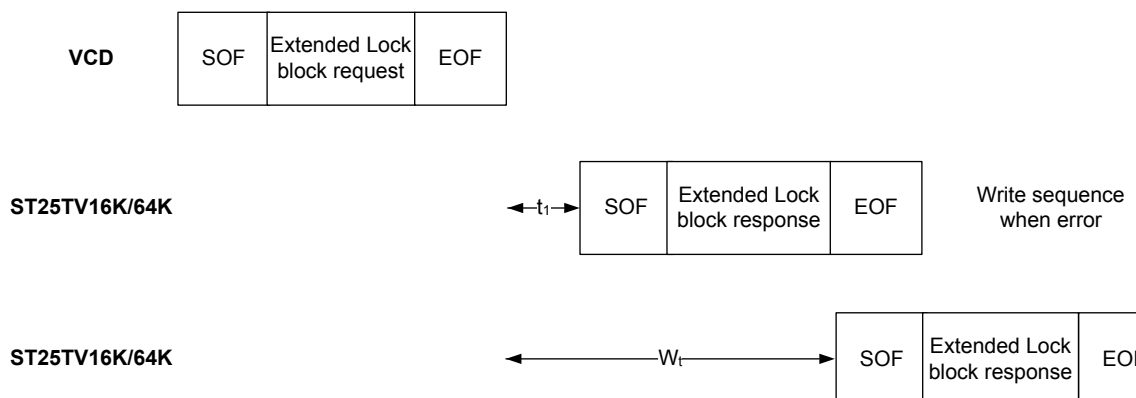
6.4.12 Read Multiple Blocks

When receiving the Read Multiple Block command, the ST25TV16K/64K reads the selected blocks and sends back their value in multiples of 32 bits in the response. The blocks are numbered from 00h to FFh in the request and the value is minus one (-1) in the field. For example, if the "Number of blocks" field contains the value 06h, seven blocks are read. The maximum number of blocks is fixed at 256 assuming that they are all located in the same area. If the number of blocks overlaps areas or overlaps the end of user memory, the ST25TV16K/64K returns an error code. When the Option_flag is set, the response returns the Block Security Status.

The Inventory_flag must be set to 0.

Block number is coded on 1 Byte and only first 256 blocks of ST25TV16K/64K can be addressed using this command.

Table 61. Read Multiple Block request format

Request SOF	Request_flags	Read Multiple Block	UID [1]	First block number	Number of blocks	CRC16	Request EOF
-	8 bits	23h	64 bits	8 bits	8 bits	16 bits	-

1. This field is optional.

Request parameters:

- Request flags
- UID (optional)
- First block number
- Number of blocks

Table 62. Read Multiple Block response format when Error_flag is NOT set

Response SOF	Response_flags	Block security status [1]	Data	CRC16	Response EOF
-	8 bits	8 bits [2]	32 bits [2]	16 bits	-

1. This field is optional.
2. Repeated as needed.

Response parameters:

- Block security status if Option_flag is set (see Table 63. Block security status)
- N blocks of data

Table 63. Block security status

b7	b6	b5	b4	b3	b2	b1	b0
Reserved for future use. All at 0.							0: Current block not locked 1: Current block locked

Table 64. Read Multiple Block response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

- Error code as Error_flag is set:
    – 03h: command option is not supported
    – 0Fh: error with no information given
    – 10h: the specified block is not available
    – 15h: the specified block is read-protected

Figure 15. Read Multiple Block frame exchange between VCD and ST25TV16K/64K
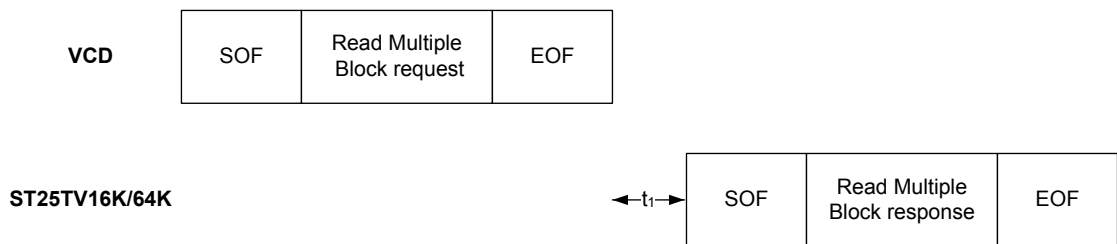
6.4.13 Extended Read Multiple Blocks

When receiving the Extended Read multiple block command, the ST25TV16K/64K reads the selected blocks and sends back their value in multiples of 32 bits in the response. The blocks are numbered from 00h to last block of memory in the request and the value is minus one (-1) in the field. For example, if the "Number of blocks" field contains the value 06h, seven blocks are read. The maximum number of blocks is fixed at 2047 assuming that they are all located in the same area. If the number of blocks overlaps areas or overlaps the end of user memory, the ST25TV16K/64K returns an error code. When the Option_flag is set, the response returns the Block Security Status.

The Inventory_flag must be set to 0.

Block number is coded on 2 Bytes so all memory blocks of ST25TV16K/64K can be addressed using this command.

Table 65. Extended Read Multiple Block request format

Request SOF	Request_flags	Extended Read Multiple Block	UID [1]	First block number	Number of blocks	CRC16	Request EOF
-	8 bits	33h	64 bits	16 bits	16 bits	16 bits	-

1. *This field is optional.*

Request parameters:
- Request flags
- UID (optional)
- First block number (from LSB byte to MSB byte)
- Number of blocks (from LSB byte to MSB byte)

Table 66. Extended Read Multiple Block response format when Error_flag is NOT set

Response SOF	Response_flags	Block security status [1]	Data	CRC16	Response EOF
-	8 bits	8 bits [2]	32 bits [2]	16 bits	-

1. *This field is optional.*
2. *Repeated as needed.*

Response parameters:
- Block security status if Option_flag is set (see Table 67. Block security status)
- N blocks of data

Table 67. Block security status

b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
Reserved for future use. All at 0							0: Current block not locked 1: Current block locked

Table 68. Extended Read Multiple Block response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:
- Error code as Error_flag is set:
  - 03h: command option is not supported
  - 0Fh: error with no information given
  - 10h: the specified block is not available
  - 15h: the specified block is read-protected

Figure 16. Extended Read Multiple Block frame exchange between VCD and ST25TV16K/64K
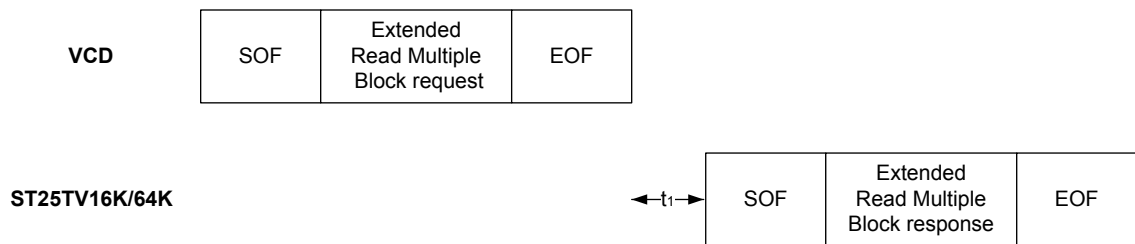
6.4.14 Write Multiple Blocks

On receiving the Write Multiple Block command, the ST25TV16K/64K writes the data contained in the request to the requested blocks, and reports whether the write operation were successful in the response. ST25TV16K/64K supports up to 4 blocks, data field must be coherent with the number of blocks to program.

If some blocks overlaps areas, or overlap end of user memory the ST25TV16K/64K returns an error code and none of the blocks are programmed.

When the Option_flag is set, wait for EOF to respond. During the RF write cycle Wt, there should be no modulation (neither 100% nor 10%), otherwise the ST25TV16K/64K may not program correctly the data into the memory. The W_t time is equal to $t_{1nom} + m \times 302$ µs < 20 ms. (m is an integer, it is function of Nb number of blocks to be programmed).

The Inventory_flag must be set to 0.

Block number is coded on 1 Byte and only first 256 blocks of ST25TV16K/64K can be addressed using this command.

Table 69. Write Multiple Block request format

Request SOF	Request_flags	Write Multiple Block	UID [1]	First Block number	Number of block [2]	Data	CRC16	Request EOF
-	8 bits	24h	64 bits	8 bits	8 bits	Block length [3]	16 bits	-

1. This field is optional.
2. The number of blocks in the request is one less than the number of blocks that the VICC shall write.
3. Repeated as needed

Request parameters:
- Request flags
- UID (optional)
- First Block number
- Number of blocks
- Data

Table 70. Write Multiple Block response format when Error_flag is NOT set

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:
- No parameter. The response is sent back after the writing cycle.

Table 71. Write Multiple Block response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:
- Error code as Error_flag is set:
  – 03h: command option is not supported
  – 0Fh: error with no information given
  – 10h: the specified block is not available
  – 12h: the specified block is locked and its contents cannot be changed
  – 13h: the specified block was not successfully programmed

Figure 17. Write Multiple Block frame exchange between VCD and ST25TV16K/64K
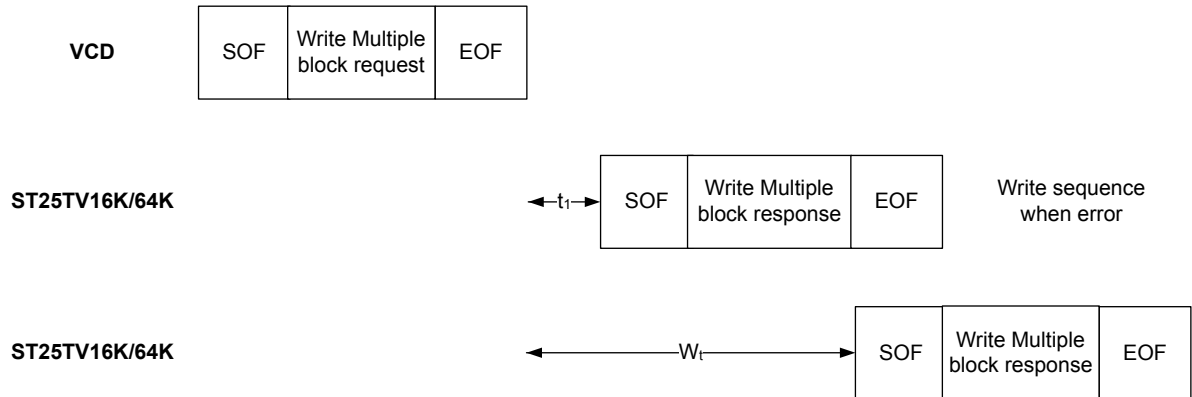
6.4.15 Extended Write Multiple Blocks

On receiving the Extended Write multiple block command, the ST25TV16K/64K writes the data contained in the request to the targeted blocks and reports whether the write operation were successful in the response. ST25TV16K/64K supports up to 4 blocks, data field must be coherent with number of blocks to program.

If some blocks overlaps areas, or overlap end of user memory the ST25TV16K/64K returns an error code and none of the blocks are programmed.

When the Option_flag is set, wait for EOF to respond. During the RF write cycle Wt, there should be no modulation (neither 100% nor 10%), otherwise the ST25TV16K/64K may not program correctly the data into the memory. The W_t time is equal to $t_{1nom} + m \times 302$ μs < 20 ms (m is an integer function of Nb number of blocks to be programmed).

The Inventory_flag must be set to 0.

Block number is coded on 2 Bytes so all memory blocks of ST25TV16K/64K can be addressed using this command.

Table 72. Extended Write Multiple Block request format

Request SOF	Request_flags	Extended Write multiple block	UID [1]	First Block number	Number of block[2]	Data	CRC16	Request EOF
-	8 bits	34h	64 bits	16 bits	16 bits	Block length [3]	16 bits	-

1. *This field is optional.*
2. *The number of blocks in the request is one less than the number of blocks that the VICC shall write.*
3. *Repeated as needed*

Request parameters:
- Request flags
- UID (optional)
- First block number (from LSB byte to MSB byte)
- Number of block (from LSB byte to MSB byte)
- Data (from first to last blocks, from LSB bytes to MSB bytes)

Table 73. Extended Write Multiple Block response format when Error_flag is NOT set

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:

• No parameter. The response is sent back after the writing cycle.

Table 74. Extended Write Multiple Block response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

• Error code as Error_flag is set:
  – 03h: command option is not supported
  – 0Fh: error with no information given
  – 10h: the specified block is not available
  – 12h: the specified block is locked and its contents cannot be changed
  – 13h: the specified block was not successfully programmed

Figure 18. Extended Write Multiple Block frame exchange between VCD and ST25TV16K/64K
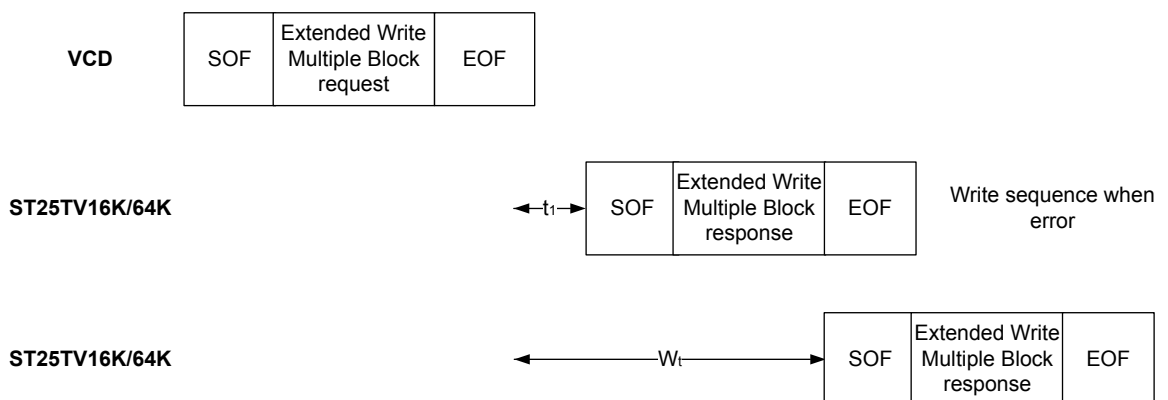
6.4.16 Select

When receiving the Select command:

• If the UID is equal to its own UID, the ST25TV16K/64K enters or stays in the Selected state and sends a response.
• If the UID does not match its own UID, the selected ST25TV16K/64K returns to the Ready state and does not send a response.

The ST25TV16K/64K answers an error code only if the UID is equal to its own UID. If not, no response is generated. If an error occurs, the ST25TV16K/64K remains in its current state.

The Option_flag is not supported. The Inventory_flag must be set to 0.

Table 75. Select request format

Request SOF	Request_flags	Select	UID	CRC16	Request EOF
-	8 bits	25h	64 bits	16 bits	-

Request parameter:

- UID

Table 76. Select Block response format when Error_flag is NOT set

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:

- No parameter

Table 77. Select response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

- Error code as Error_flag is set:
  – 03h: the option is not supported
  – 0Fh: error with no information given

Figure 19. Select frame exchange between VCD and ST25TV16K/64K
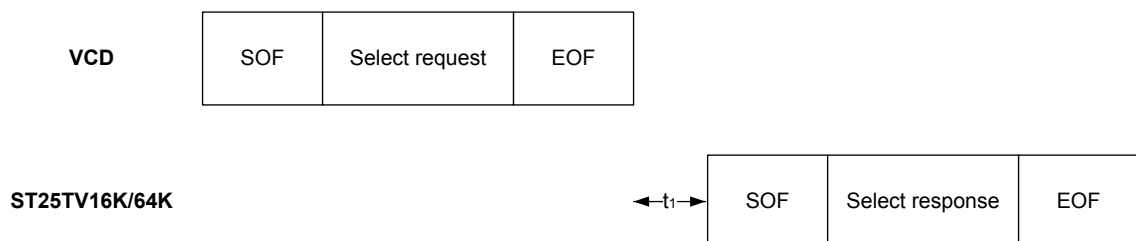
6.4.17 Reset to Ready

On receiving a Reset to Ready command, the ST25TV16K/64K returns to the Ready state if no error occurs. In the Addressed mode, the ST25TV16K/64K answers an error code only if the UID is equal to its own UID. If not, no response is generated.

The Option_flag is not supported. The Inventory_flag must be set to 0.

Table 78. Reset to Ready request format

Request SOF	Request_flags	Reset to Ready	UID [1]	CRC16	Request EOF
-	8 bits	26h	64 bits	16 bits	-

1. This field is optional.

Request parameter:

- UID (optional)

Table 79. Reset to Ready response format when Error_flag is NOT set

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:

• No parameter

Table 80. Reset to ready response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

• Error code as Error_flag is set:
  – 03h: the option is not supported
  – 0Fh: error with no information given

Figure 20. Reset to Ready frame exchange between VCD and ST25TV16K/64K
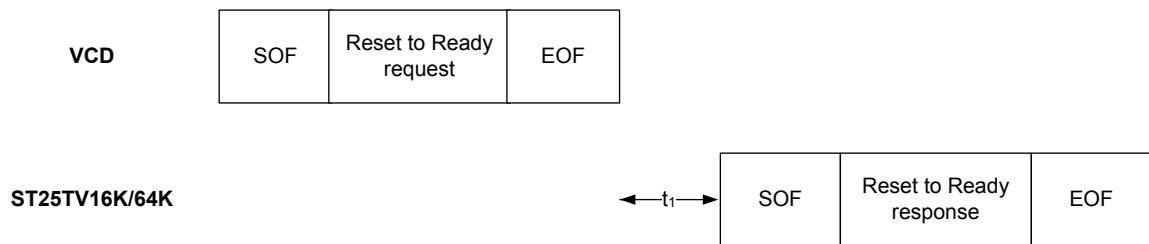
6.4.18 Write AFI

On receiving the Write AFI request, the ST25TV16K/64K programs the 8-bit AFI value to its memory. When the Option_flag is set, wait for EOF to respond.

During the RF write cycle W_t, there should be no modulation (neither 100% nor 10%), otherwise the ST25TV16K/64K may not write correctly the AFI value into the memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

The Inventory_flag must be set to 0.

Table 81. Write AFI request format

Request SOF	Request_flags	Write AFI	UID [1]	AFI	CRC16	Request EOF
-	8 bits	27h	64 bits	8 bits	16 bits	-

1. This field is optional.

Request parameter:

• Request flags
• UID (optional)
• AFI

Table 82. Write AFI response format when Error_flag is NOT set

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:

• No parameter

Table 83. Write AFI response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

• Error code as Error_flag is set

– 03h: command option is not supported

– 0Fh: error with no information given

– 12h: the specified block is locked and its contents cannot be changed

– 13h: the specified block was not successfully programmed

Figure 21. Write AFI frame exchange between VCD and ST25TV16K/64K
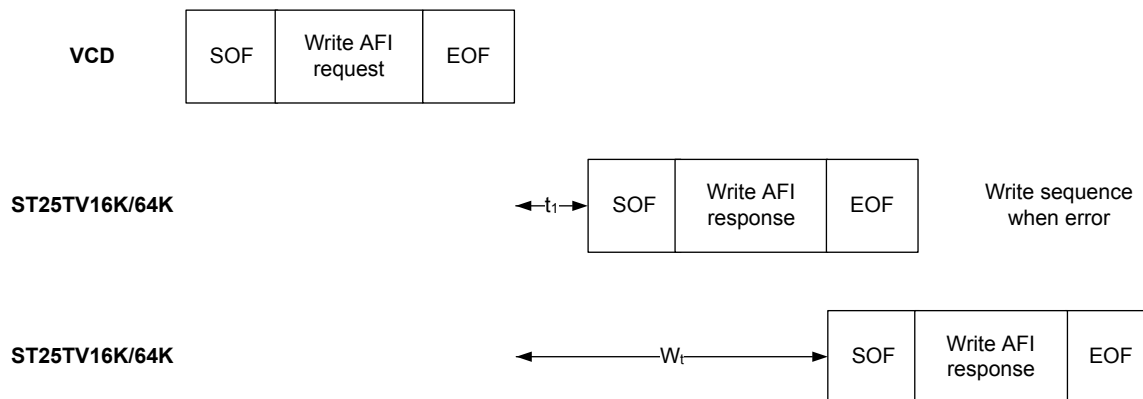
6.4.19 Lock AFI

On receiving the Lock AFI request, the ST25TV16K/64K locks the AFI value permanently. When the Option_flag is set, wait for EOF to respond.

The Inventory_flag must be set to 0.

During the RF write cycle W_t, there should be no modulation (neither 100% nor 10%), otherwise the ST25TV16K/64K may not lock correctly the AFI value in memory. The W_t time is equal to $t_{1nom} + N \times 302$ µs (N is an integer).

Table 84. Lock AFI request format

Request SOF	Request_flags	Lock AFI	UID [1]	CRC16	Request EOF
-	8 bits	28h	64 bits	16 bits	-

1. This field is optional.

Request parameter:
- Request Flags
- UID (optional)

Table 85. Lock AFI response format when Error_flag is NOT set

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:
- No parameter

Table 86. Lock AFI response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:
- Error code as Error_flag is set
    - 03h: command option is not supported
    - 0Fh: error with no information given
    - 11h: the specified block is already locked and thus cannot be locked again
    - 14h: the specified block was not successfully locked

Figure 22. Lock AFI frame exchange between VCD and ST25TV16K/64K
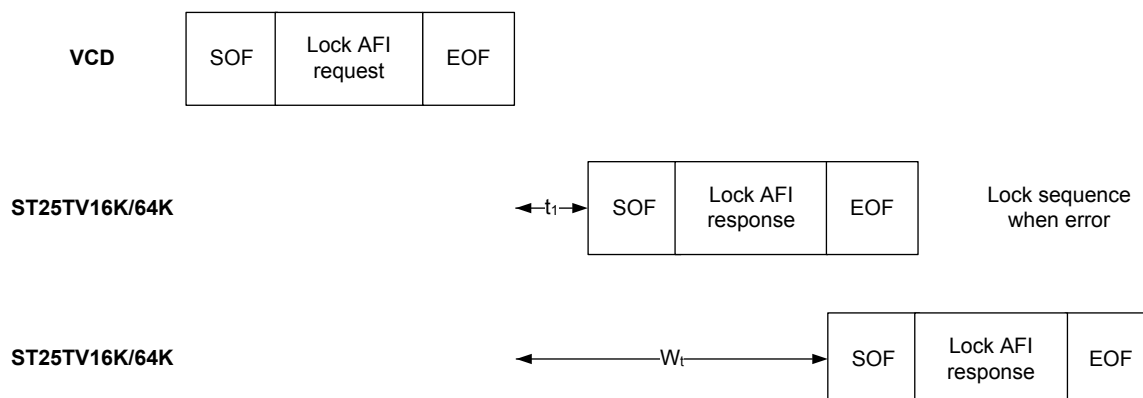
6.4.20 **Write DSFID**

On receiving the Write DSFID request, the ST25TV16K/64K programs the 8-bit DSFID value to its memory. When the Option_flag is set, wait for EOF to respond.

The Inventory_flag must be set to 0.

During the RF write cycle W_t, there should be no modulation (neither 100% nor 10%), otherwise the ST25TV16K/64K may not write correctly the DSFID value in memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Table 87. Write DSFID request format

Request SOF	Request_flags	Write DSFID	UID [1]	DSFID	CRC16	Request EOF
-	8 bits	29h	64 bits	8 bits	16 bits	-

1. This field is optional.

Request parameter:
- Request flags
- UID (optional)
- DSFID

Table 88. Write DSFID response format when Error_flag is NOT set

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:
- No parameter

Table 89. Write DSFID response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:
- Error code as Error_flag is set
    - 03h: command option is not supported
    - 0Fh: error with no information given
    - 12h: the specified block is locked and its contents cannot be changed
    - 13h: the specified block was not successfully programmed

Figure 23. Write DSFID frame exchange between VCD and ST25TV16K/64K
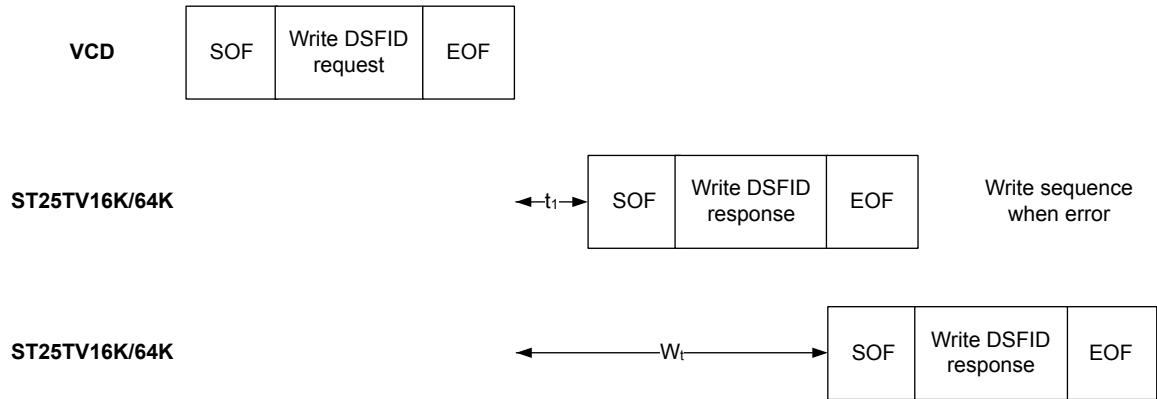
6.4.21 Lock DSFID

On receiving the Lock DSFID request, the ST25TV16K/64K locks the DSFID value permanently. When the Option_flag is set, wait for EOF to respond.

The Inventory_flag must be set to 0.

During the RF write cycle W_t, there should be no modulation (neither 100% nor 10%), otherwise the ST25TV16K/64K may not lock correctly the DSFID value in memory. The W_t time is equal to $t_{1nom} + N \times 302$ µs (N is an integer).

Table 90. Lock DSFID request format

Request SOF	Request_flags	Lock DSFID	UID [1]	CRC16	Request EOF
-	8 bits	2Ah	64 bits	16 bits	-

1. This field is optional.

Request parameter:
- Request flags
- UID (optional)

Table 91. Lock DSFID response format when Error_flag is NOT set

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:
- No parameter.

Table 92. Lock DSFID response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

- Error code as Error_flag is set:
  - 03h: command option is not supported
  - 0Fh: error with no information given
  - 11h: the specified block is already locked and thus cannot be locked again
  - 14h: the specified block was not successfully locked

Figure 24. Lock DSFID frame exchange between VCD and ST25TV16K/64K
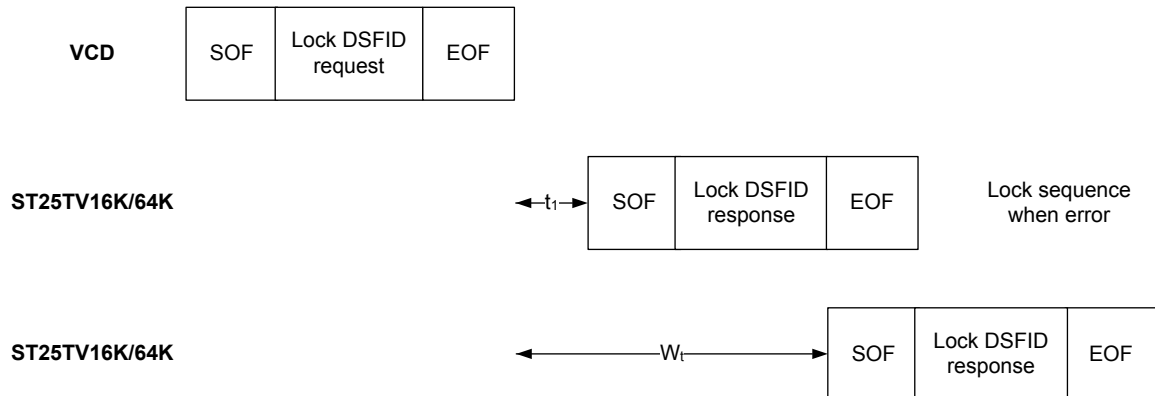
6.4.22 Get System Info

When receiving the Get System Info command, the ST25TV16K/64K sends back its information data in the response. The Option_flag is not supported. The Get System Info can be issued in both Addressed and Non Addressed modes.

The Inventory_flag must be set to 0.

Table 93. Get System Info request format

Request SOF	Request_flags	Get System Info	UID [1]	CRC16	Request EOF
-	8 bits	2Bh	64 bits	16 bits	-

1. *This field is optional.*

Request parameter:
- Request flags
- UID (optional)

Table 94. Get System Info response format Error_flag is NOT set

Response SOF	Response_flags	Information flags	UID	DSFID	AFI	IC ref.	CRC16	Response EOF
-	00h	0Fh	64bits	8 bits	8 bits	48h	16 bits	-

Response parameters:
- Information flags set to 0Bh. DSFID, AFI, and IC reference fields are present.
- UID code on 64 bits
- DSFID value
- AFI value

- IC reference: the 8 bits are significant.

Table 95. Get System Info response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	01h	8 bits	16 bits	-

Response parameter:

- Error code as Error_flag is set:
  - 03h: Option not supported
  - 0Fh: error with no information given

Figure 25. Get System Info frame exchange between VCD and ST25TV16K/64K
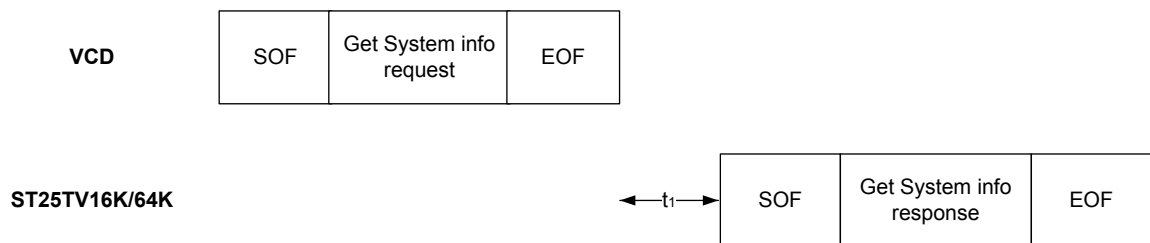
6.4.23 Extended Get System Info

When receiving the Extended Get System Info command, the ST25TV16K/64K sends back its information data in the response. The Option_flag is not supported. The Extended Get System Info can be issued in both Addressed and Non Addressed modes.

The Inventory_flag must be set to 0.

Table 96. Extended Get System Info request format

Request SOF	Request_flags	Extended Get System Info	Parameter request field	UID [1]	CRC16	Request EOF
-	8 bits	3Bh	8 bits	64 bits	16 bits	-

1. This field is optional.

- Request flags
- Request parameters
- UID (optional)

M

Table 97. Parameter request list

Bit	Flag name	Value	Description
b1	DSFID	0	No request of DSFID
		1	Request of DSFID

Bit	Flag name	Value	Description
b2	AFI	0	No request of AFI
		1	Request of AFI
b3	VICC memory size	0	No request of data field on VICCmemory size
		1	Request of data field on VICCmemory size
b4	IC reference	0	No request of Information on IC reference
		1	Request of Information on IC reference
b5	MOI	1	Information on MOI always returned in response flag
b6	VICC Command list	0	No request of Data field of all supported commands
		1	Request of Data field of all supported commands
b7	CSI Information	0	No request of CSI list
		1	Request of CSI list
b8	Extended Get System Info parameter Field	0	One byte length of Extended Get System Info parameter field

Table 98. Extended Get System Info response format when Error_flag is NOT set

Response SOF	Response_flags	Information flags	UID	DSFID [1] [2]	AFI[1][2]	Other Field[1][2]	CRC16	Response EOF
-	00h	8 bits[1]	64 bits	8 bits	8 bits	up to 64 bits [3]	16 bits	-

1. See *Table 99. Response Information Flag*.
2. This field is optional.
3. Number of bytes is function of parameter list selected.

Response parameters:
*   Information flag defining which fields are present
*   UID code on 64 bits
*   DSFID value (if requested in Parameters request field)
*   AFI value (if requested in Parameters request field)
*   Other fields:
    –   VICC Memory size (if requested in Parameters request field)
    –   ICRef(if requested in Parameters request field)
    –   VICC Command list (if requested in Parameters request field)

Table 99. Response Information Flag

Bit	Flag name	Value	Description
b1	DSFID	0	DSFID field is not present
		1	DSFID field is present
b2	AFI	0	AFI field is not present
		1	AFI field is present
b3	VICC memory size	0	Data field on VICC memory size is not present.
		1	Data field on VICC memory size is present.

Bit	Flag name	Value	Description
b4	IC reference	0	Information on IC reference field is not present.
		1	Information on IC reference field is present.
b5	MOI	0	1 byte addressing
1	Data field of all supported commands is present	b6	VICCCommand list
b7	CSI Information	0	CSI list is not present
b8	Info flag field	0	One byte length of info flag field

Table 100. Response other field: ST25TV16K/64K VICC memory size

MSB				LSB	
24	22	21	17	16	01
RFU		Block size in byte		Number of blocks	
0h		03h		ST25TV16K 01FFh ST25TV64K 07FFh	

Table 101. Response other field: ST25TV16K/64K IC Ref

1 byte
ICRef
48h

Table 102. Response other field: ST25TV16K/64K VICC command list

MSB							LSB
32	25	24	17	16	09	08	01
Byte 4		Byte 3		Byte 2		Byte 1	
00h		3Fh		3Fh		FFh	

Table 103. Response other field: ST25TV16K/64K VICC command list Byte 1

Bit	Meaning if bit is set	Comment
b1	Read single block is supported	-
b2	Write single block is supported	-
b3	Lock single block is supported	-
b4	Read multiple block is supported	-
b5	Write multiple block is supported	-
b6	Select is supported	including Select state
b7	Reset to Ready is supported	-
b8	Get multiple block security status is supported	-

Table 104. Response other field: ST25TV16K/64K VICC command list Byte 2

Bit	Meaning if bit is set	Comment
b1	Write AFI is supported	-
b2	Lock AFI is supported	-
b3	Write DSFID is supported	-
b4	Lock DSFID is supported	-
b5	Get System Information is supported	-
b6	Custom commands are supported	-
b7	RFU	0 shall be returned
b8	RFU	0 shall be returned

Table 105. Response other field: ST25TV16K/64K VICC command list Byte 3

Bit	Meaning if bit is set	Comment
b1	Extended read single block is supported	-
b2	Extended write single block is supported	-
b3	Extended lock single block is supported	-
b4	Extended read multiple block is supported	-
b5	Extended write multiple block is supported	-
b6	Extended Get Multiple Security Status is supported	-
b7	RFU	0 shall be returned
b8	RFU	0 shall be returned

Table 106. Response other field: ST25TV16K/64K VICC command list Byte 4

Bit	Meaning if bit is set	Comment
b1	Read Buffer is supported	Means Response Buffer is supported
b2	Select Secure State is supported	Means VCD or Mutual authentication are supported
b3	Final Response always includes crypto result	Means that flag b3 will be set in the Final response
b4	AuthComm crypto format is supported	-
b5	SecureComm crypto format is supported	-
b6	KeyUpdate is supported	-
b7	Challenge is supported	-
b8	If set to 1 a further Byte is transmitted	0 shall be returned

Table 107. Extended Get System Info response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	01h	8 bits	16 bits	-

Response parameter:

- Error code as Error_flag is set:
  - 03h: Option not supported
  - 0Fh: error with no information given

Figure 26. Extended Get System Info frame exchange between VCD and ST25TV16K/64K

| VCD | SOF | Extended Get System Info request | EOF |

| ST25TV16K/64K | ←t₁→ | SOF | Extended Get System Info response | EOF |
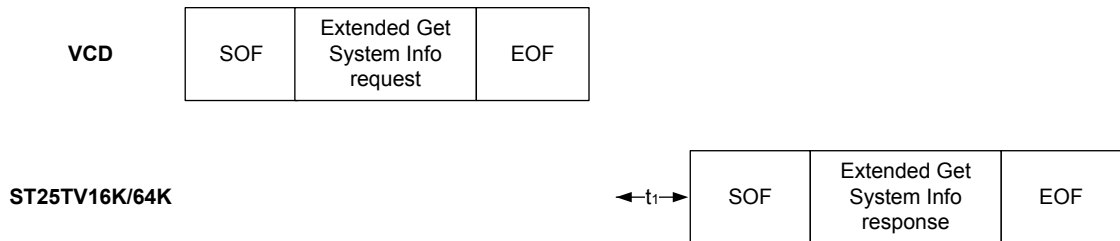
6.4.24 Get Multiple Block Security Status

When receiving the Get Multiple Block Security Status command, the ST25TV16K/64K sends back its security status for each address block: 0 when block is writable else 1 when block is locked for writing. The blocks security status are defined by the area security status (and by LCK_CCFILE register for blocks 0 and 1). The blocks are numbered from 00h up to the maximum memory block number in the request, and the value is minus one (−1) in the field. For example, a value of "06" in the "Number of blocks" field requests will return the security status of seven blocks. This command does not respond an error if number of blocks overlap areas or overlaps the end of user memory.

The number of blocks is coded on 1 Byte and only first 256 blocks of ST25TV16K/64K can be addressed using this command.

The Option_flag is not supported. The Inventory_flag must be set to 0.

Table 108. Get Multiple Block Security Status request format

Request SOF	Request_flags	Get Multiple Block Security Status	UID [1]	First block number	Number of blocks	CRC16	Request EOF
-	8 bits	2Ch	64 bits	8 bits	8 bits	16 bits	-

1. This field is optional.

Request parameter:
- Request flags
- UID (optional)
- First block number
- Number of blocks

Table 109. Get Multiple Block Security Status response format when Error_flag is NOT set

Response SOF	Response_flags	Block security status	CRC16	Response EOF
-	8 bits	8 bits [1]	16 bits	-

1. Repeated as needed.

Response parameters:
- Block security status

Table 110. **Block security status**

b$_7$	b$_6$	b$_5$	b$_4$	b$_3$	b$_2$	b$_1$	b$_0$
Reserved for future use All at 0							0: Current block not locked 1: Current block locked

Table 111. **Get Multiple Block Security Status response format when Error_flag is set**

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

- Error code as Error_flag is set:
    - 03h: the option is not supported
    - 0Fh: error with no information given
    - 10h: the specified block is not available

Figure 27. **Get Multiple Block Security Status frame exchange between VCD and ST25TV16K/64K**
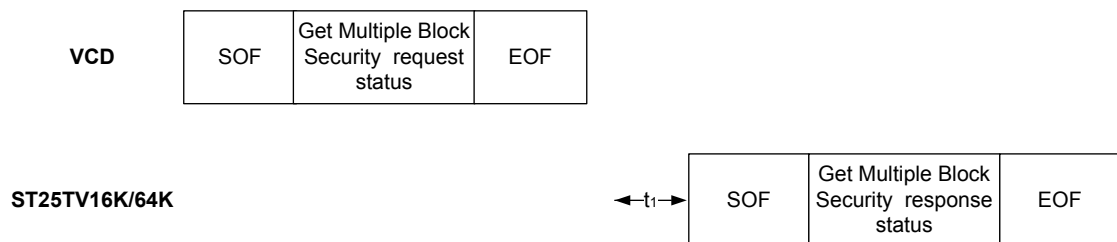
6.4.25 Extended Get Multiple Block Security Status

When receiving the Extended Get Multiple Block Security Status command, the ST25TV16K/64K sends back the security status for each address block: 0 when the block is writable else 1 when block is locked for writing. The block security statuses are defined by the area security status. The blocks are numbered from 00h up to the maximum memory block number in the request, and the value is minus one (–1) in the field. For example, a value of '06' in the "Number of blocks" field requests to return the security status of seven blocks.

This command does not respond an error if number of blocks overlap areas or overlaps the end of user memory.

The number of blocks is coded on 2 Bytes so all memory blocks of ST25TV16K/64K can be addressed using this command.

The Option_flag is not supported. The Inventory_flag must be set to 0.

Table 112. **Extended Get Multiple Block Security Status request format**

Request SOF	Request_flags	Extended Get Multiple Block Security Status	UID [1]	First block number	Number of blocks	CRC16	Request EOF
-	8 bits	3Ch	64 bits	16 bits	16 bits	16 bits	-

1. *This field is optional.*

Request parameter:

- Request flags
- UID (optional)
- First block number (from LSB byte to MSB byte)
- Number of blocks (from LSB byte to MSB byte)

Table 113. Extended Get Multiple Block Security Status response format when Error_flags NOT set

Response SOF	Response_flags	Block security status	CRC16	Response EOF
-	8 bits	8 bits [1]	16 bits	-

1. Repeated as needed.

Response parameters:

Block security status

Table 114. Block security status

b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
Reserved for future use							0: Current block not locked
All at 0							1: Current block locked

Table 115. Extended Get Multiple Block Security Status response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:
- Error code as Error_flag is set:
  – 03h: the option is not supported
  – 0Fh: error with no information given
  – 10h: the specified block is not available

Figure 28. Extended Get Multiple Block Security Status frame exchange between VCD and ST25TV16K/64K
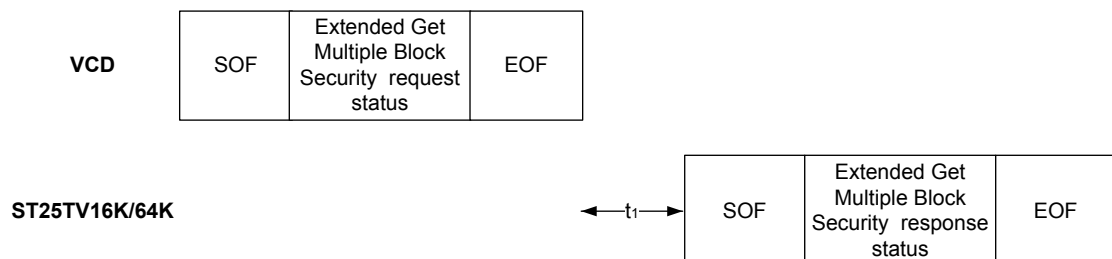
6.4.26 Read Configuration

On receiving the Read Configuration command, the ST25TV16K/64K reads the static system configuration register at the Pointer address and sends back its 8-bit value in the response.

The Option_flag is not supported. The Inventory_flag must be set to 0.

Table 116. Read Configuration request format

Request SOF	Request_flags	Read Configuration	IC Mfg code	UID[1]	Pointer	CRC16	Request EOF
-	8 bits	A0h	02h	64 bits	8 bits	16 bits	-

1. This field is optional.

Note: Please refer to Table 7. System configuration memory map for details on register addresses.

Request parameters:

- System configuration register pointer
- UID (optional)

Table 117. Read Configuration response format when Error_flag is NOT set

Response SOF	Response_flags	Register value	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameters:

- One byte of data: system configuration register

Table 118. Read Configuration response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

- Error code as Error_flag is set
    - 02h: command not recognized
    - 03h: the option is not supported
    - 10h: block not available
    - 0Fh: error with no information given

Figure 29. Read Configuration frame exchange between VCD and ST25TV16K/64K
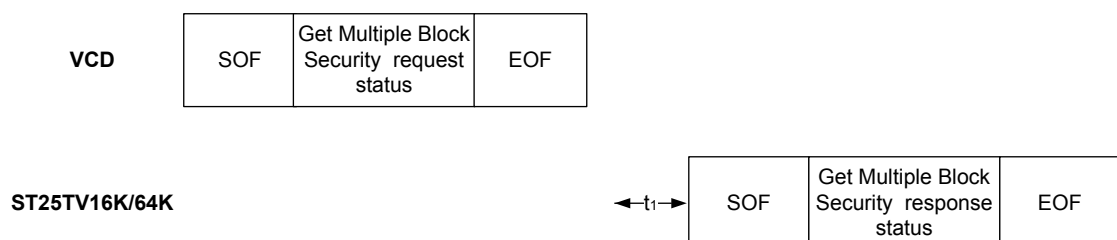
6.4.27 Write Configuration

The Write Configuration command is used to write static system configuration register. The Write Configuration must be preceded by a valid presentation of the RF configuration password (00) to open the RF configuration security session.

On receiving the Write Configuration command, the ST25TV16K/64K writes the data contained in the request to the system configuration register at the Pointer address and reports whether the write operation was successful in the response or not.

When the Option_flag is set, wait for EOF to respond. The Inventory_flag is not supported.

During the RF write cycle W_t, there should be no modulation (neither 100% nor 10%), otherwise the ST25TV16K/64K may not program correctly the data into the Configuration byte. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Table 119. Write Configuration request format

Request SOF	Request_flags	Write Configuration	IC Mfg code	UID [1]	Pointer	Register Value [2]	CRC16	Request EOF
-	8 bits	A1h	02h	64 bits	8 bits	8 bits	16 bits	-

1. This field is optional.
2. Before updating the register value, check the meaning of each bit in previous sections.

Request parameters:
- Request flags
- Register pointer
- Register value
- UID (optional)

Table 120. Write Configuration response format when Error_flag is NOT set

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Note: *Please refer to Table 7. System configuration memory map for details on register addresses.*

Response parameter:
- No parameter. The response is sent back after the writing cycle.

Table 121. Write Configuration response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:
- Error code as Error_flag is set:
  - 02h: command not recognized
  - 03h: command option is not supported
  - 0Fh: error with no information given
  - 10h: block not available
  - 12h: block already locked, content can't change

– 13h: the specified block was not successfully programmed

Figure 30. Write Configuration frame exchange between VCD and ST25TV16K/64K
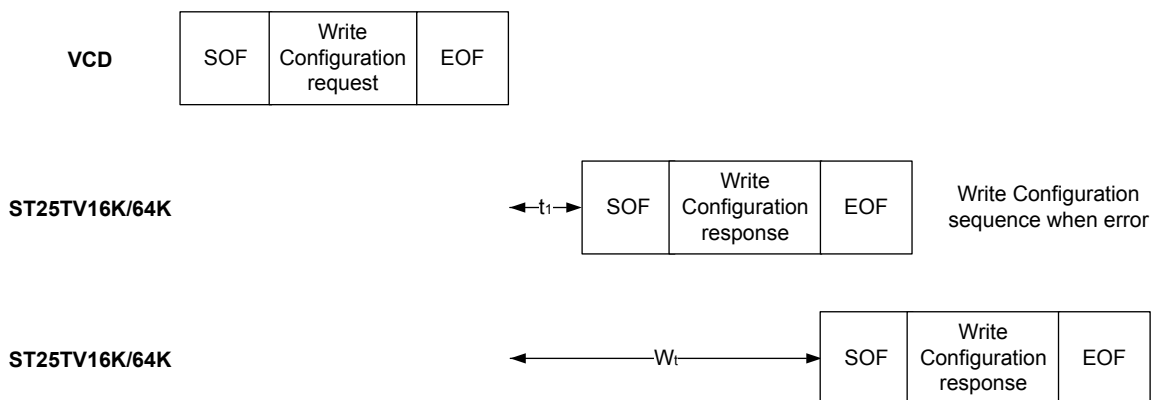
6.4.28 Write Password

On receiving the Write Password command, the ST25TV16K/64K uses the data contained in the request to write the password and reports whether the operation was successful in the response. It is possible to modify a Password value only after issuing a valid Present password command (of the same password number). When the Option_flag is set, wait for EOF to respond. Refer to Section 5.2 Data Protection for details on password Management.

The Inventory_flag must be set to 0.

During the RF write cycle time, W_t, there must be no modulation at all (neither 100% nor 10%), otherwise the ST25TV16K/64K may not correctly program the data into the memory.

The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer). After a successful write, the new value of the selected password is automatically activated. It is not required to present the new password value until the ST25TV16K/64K power-down.

Caution: To make the application more robust, it is recommended to use addressed or selected mode during write password operations to get the traceability of which tags/UID have been programmed.

Table 122. Write Password request format

Request SOF	Request_flags	Write password	IC Mfg code	UID [1]	Password number	Data	CRC16	Request EOF
-	8 bits	B1h	02h	64 bits	8 bits	64 bits	16 bits	-

1. *This field is optional.*

Request parameter:
- Request flags
- UID (optional)
- Password number:
  – 00h = PWD_0 configuration password
  – 01h = PWD_1
  – 02h = PWD_2
  – 03h = PWD_3
  – other = Error
- Data

Table 123. Write Password response format when Error_flag is NOT set

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:

• no parameter.

Table 124. Write Password response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

• Error code as Error_flag is set:
  – 02h: command not recognized
  – 03h: command option not supported
  – 10h: the password number is incorrect
  – 12h: update right not granted, Present Password command not previously executed successfully
  – 13h: the specified block was not successfully programmed

Figure 31. Write Password frame exchange between VCD and ST25TV16K/64K
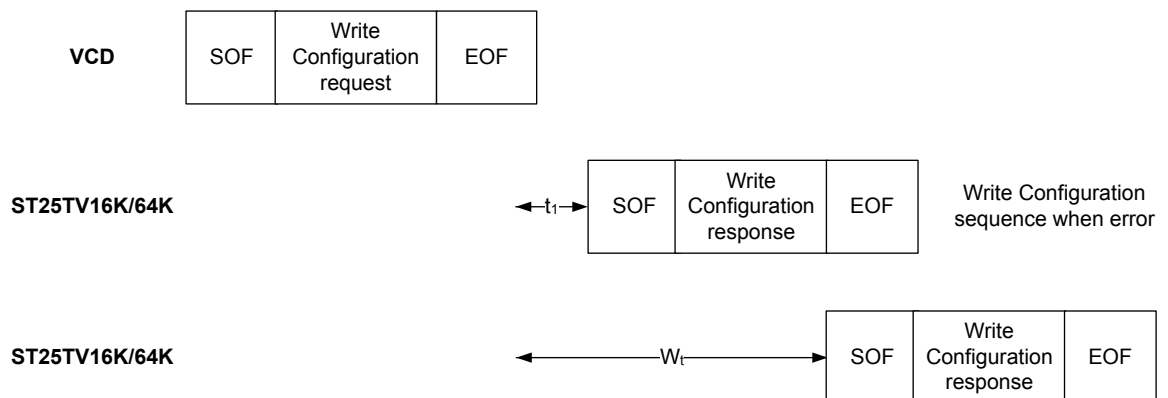
6.4.29 Present Password

On receiving the Present Password command, the ST25TV16K/64K compares the requested password with the data contained in the request and reports if the operation has been successful in the response. Refer to Section 5.2 Data Protection for details on password Management. After a successful command, the security session associated to the password is open as described in Section 5.2 Data Protection.

The Option_flag is not supported. The Inventory_flag must be set to 0.

Table 125. **Present Password request format**

Request SOF	Request_flags	Present Password	IC Mfg code	UID [1]	Password number	Password	CRC16	Request EOF
-	8 bits	B3h	02h	64 bits	8 bits	64 bits	16 bits	-

1. This field is optional.

Request parameter:

- Request flags
- UID (optional)
- Password number (00h = Password configuration, 0x01 = PWD_1, 0x02 = PWD_2, 0x03 = PWD_3, other = Error)
- Password

Table 126. **Present Password response format when Error_flag is NOT set**

Response SOF	Response_flags	CRC16	Response EOF
-	8 bits	16 bits	-

Response parameter:

- No parameter. The response is sent back after the write cycle.

Table 127. **Present Password response format when Error_flag is set**

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

- Error code as Error_flag is set:
    - 02h: command not recognized
    - 03h: command option not supported
    - 0Fh: the present password is incorrect
    - 10h: the password number is incorrect

Figure 32. **Present Password frame exchange between VCD and ST25TV16K/64K**
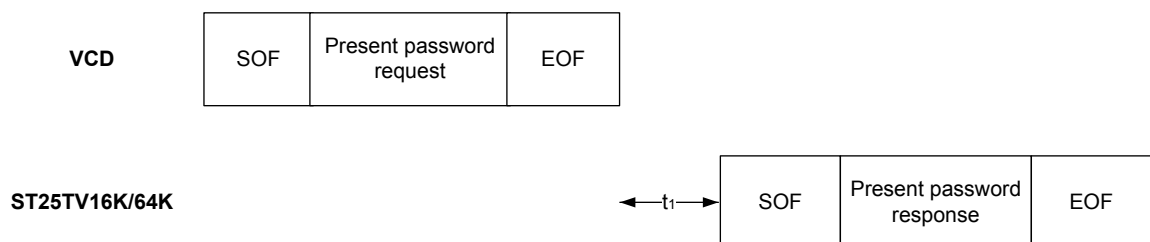
6.4.30 Fast Read Single Block

On receiving the Fast Read Single Block command, the ST25TV16K/64K reads the requested block and sends back its 32-bit value in the response. When the Option_flag is set, the response includes the Block Security Status. The data rate of the response is multiplied by 2.

The subcarrier_flag should be set to 0, otherwise the ST25TV16K/64K answers with an error code.

The Inventory_flag must be set to 0.

Block number is coded on 1 Byte and only first 256 blocks of ST25TV16K/64K can be addressed using this command.

Table 128. Fast Read Single Block request format

Request SOF	Request_flags	Fast Read Single Block	IC Mfg code	UID [1]	Block number	CRC16	Request EOF
-	8 bits	C0h	02h	64 bits	8 bits	16 bits	-

1. This field is optional.

Request parameters:
- Request flags
- UID (optional)
- Block number

Table 129. Fast Read Single Block response format when Error_flag is NOT set

Response SOF	Response_flags	Block security status [1]	Data	CRC16	Response EOF
-	8 bits	8 bits	32 bits	16 bits	-

1. This field is optional.

Response parameters:
- Block security status if Option_flag is set (see Table 130. Block security status)
- Four bytes of block data

Table 130. Block security status

b$_7$	b$_6$	b$_5$	b$_4$	b$_3$	b$_2$	b$_1$	b$_0$
Reserved for future use All at 0							0: Current Block not locked 1: Current Block locked

Table 131. Fast Read Single Block response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:
- Error code as Error_flag is set:
    - 02h: command not recognized
    - 03h: command option not supported
    - 0Fh: error with no information given
    - 10h: the specified block is not available
    - 15h: the specified block is read-protected

Figure 33. Fast Read Single Block frame exchange between VCD and ST25TV16K/64K
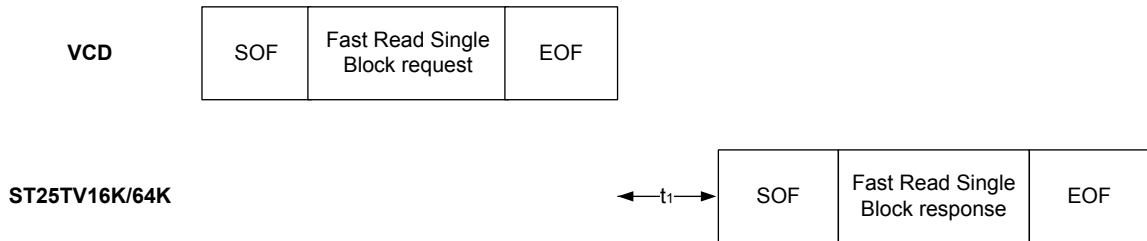
6.4.31 Fast Extended Read Single Block

On receiving the Fast Extended Read Single Block command, the ST25TV16K/64K reads the requested block and sends back its 32-bit value in the response. When the Option_flag is set, the response includes the Block Security Status. The data rate of the response is multiplied by 2.

The subcarrier_flag should be set to 0, otherwise the ST25TV16K/64K answers with an error code.

The Inventory_flag must be set to 0.

Block number is coded on 2 Bytes so all memory blocks of ST25TV16K/64K can be addressed using this command

Table 132. Fast Extended Read Single Block request format

Request SOF	Request_flags	Fast Extended Read Single Block	IC Mfg code	UID [1]	Block number	CRC16	Request EOF
-	8 bits	C4h	02h	64 bits	16 bits	16 bits	-

1. *This field is optional.*

Request parameters:
- Request flags
- UID (optional)
- Block number (from LSB byte to MSB byte)

Table 133. Fast Extended Read Single Block response format when Error_flag is NOT set

Response SOF	Response_flags	Block security status [1]	Data	CRC16	Response EOF
-	8 bits	8 bits	32 bits	16 bits	-

1. *This field is optional.*

Response parameters:
- Block security status if Option_flag is set (see Table 130. Block security status)
- Four bytes of block data

Table 134. Block security status

b7	b6	b5	b4	b3	b2	b1	b0
Reserved for future use							0: Current Block not locked
All at 0							1: Current Block locked

Table 135. Fast Extended Read Single Block response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:
- Error code as Error_flag is set:
  - 02h: command not recognized
  - 03h: command option not supported
  - 0Fh: error with no information given
  - 10h: the specified block is not available
  - 15h: the specified block is read-protected

Figure 34. Fast Extended Read Single Block frame exchange between VCD and ST25TV16K/64K
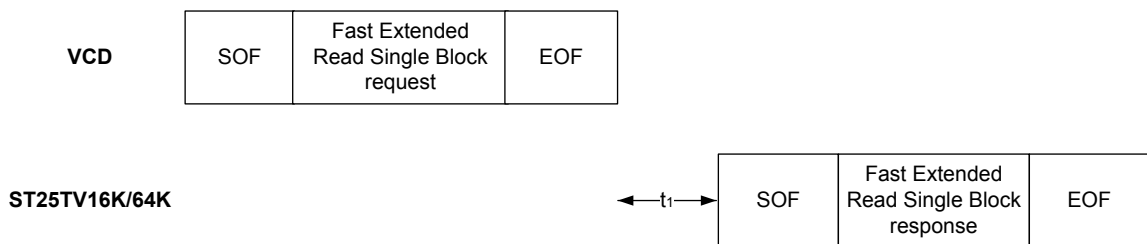
6.4.32 Fast Read Multiple Blocks

On receiving the Fast Read Multiple Blocks command, the ST25TV16K/64K reads the selected blocks and sends back their value in multiples of 32 bits in the response. The blocks are numbered from 00h up to the last block of user memory in the request, and the value is minus one (-1) in the field. For example, if the "Number of blocks" field contains the value 06h, seven blocks are read. The maximum number of blocks is fixed to 256 assuming that they are all located in the same area. If the number of blocks overlaps area or overlap the end of user memory, the ST25TV16K/64K returns an error code.

The Inventory_flag must be set to 0.

When the Option_flag is set, the response includes the Block Security Status. The data rate of the response is multiplied by 2.

The subcarrier_flag should be set to 0, otherwise the ST25TV16K/64K answers with an error code.

Block number is coded on 1 Byte and only first 256 blocks of ST25TV16K/64K can be addressed using this command.

Table 136. Fast Read Multiple Block request format

Request SOF	Request_flags	Fast Read Multiple Block	IC Mfg code	UID [1]	First block number	Number of blocks	CRC16	Request EOF
-	8 bits	C3h	02h	64 bits	8 bits	8 bits	16 bits	-

1. This field is optional.

Request parameters:
- Request flag
- UID (Optional)
- First block number (from LSB byte to MSB byte)

- Number of blocks (from LSB byte to MSB byte)

Table 137. Fast Read Multiple Block response format when Error_flag is NOT set

Response SOF	Response_flags	Block security status [1]	Data	CRC16	Response EOF
-	8 bits	8 bits [2]	32 bits[2]	16 bits	-

1. *This field is optional.*
2. *Repeated as needed.*

Response parameters:
- Block security status if Option_flag is set (see Table 138. Block security status if Option_flag is set)
- N block of data

Table 138. Block security status if Option_flag is set

b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
Reserved for future use All at 0							0: Current not locked 1: Current locked

Table 139. Fast Read Multiple Block response format when Error_flag is set

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:
- Error code as Error_flag is set:
  - 02h: command not recognized
  - 0Fh: error with no information given
  - 03h: the option is not supported
  - 10h: block address not available
  - 15h: block read-protected

Figure 35. Fast Read Multiple Block frame exchange between VCD and ST25TV16K/64K
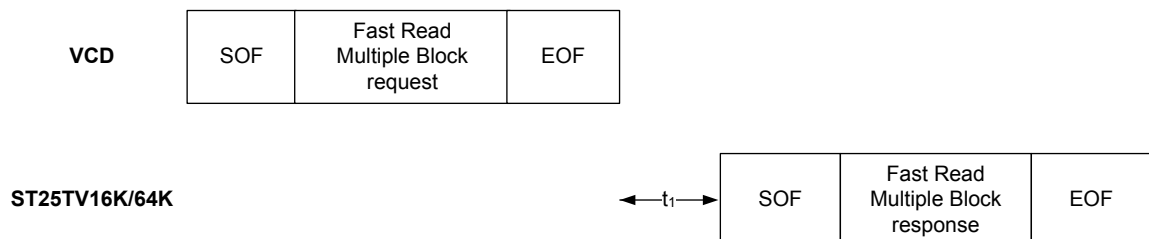
6.4.33 **Fast Extended Read Multiple Block**

On receiving the Fast Extended Read Multiple Block command, the ST25TV16K/64K reads the selected blocks and sends back their value in multiples of 32 bits in the response. The blocks are numbered from 00h to up to the last block of memory in the request and the value is minus one (–1) in the field. For example, if the "Number of blocks" field contains the value 06h, seven blocks are read. The maximum number of blocks is fixed to 2047 assuming that they are all located in the same area. If the number of blocks overlaps several areas or overlaps the end of user memory, the ST25TV16K/64K returns an error code.

When the Option_flag is set, the response includes the Block Security Status. The data rate of the response is multiplied by 2.

The subcarrier_flag should be set to 0, otherwise the ST25TV16K/64K answers with an error code.

The Inventory_flag must be set to 0.

Block number is coded on 2 Bytes so all memory blocks of ST25TV16K/64K can be addressed using this command.

Table 140. Fast Extended Read Multiple Block request format

Request SOF	Request_flags	Fast Extended Read Multiple Block	IC Mfg code	UID [1]	First block number	Block Number	CRC16	Request EOF
-	8 bits	C5h	02h	64 bits	16 bits	16 bits	16 bits	-

1. *This field is optional.*

Request parameters:
- Request flag
- UID (Optional)
- First block number (from LSB byte to MSB byte)
- Number of blocks (from LSB byte to MSB byte)

Table 141. Fast Extended Read Multiple Block response format when Error_flag is NOT set

Response SOF	Response_flags	Block security status [1]	Data	CRC16	Response EOF
-	8 bits	8 bits [2]	32 bits Table 142. Block security status if Option_flag is set	16 bits	-

1. *This field is optional.*
2. *Repeated as needed.*

Response parameters:
- Block security status if Option_flag is set (see Table 138. Block security status if Option_flag is set)
- N block of data

Table 142. Block security status if Option_flag is set

b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
Reserved for future use All at 0							0: Current not locked 1: Current locked

Table 143. **Fast Read Multiple Block response format when Error_flag is set**

Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

- Error code as Error_flag is set:
    – 02h: command not recognized
    – 03h: the option is not supported
    – 0Fh: error with no information given
    – 10h: block address not available
    – 15h: block read-protected

Figure 36. **Fast Extended Read Multiple Block frame exchange between VCD and ST25TV16K/64K**
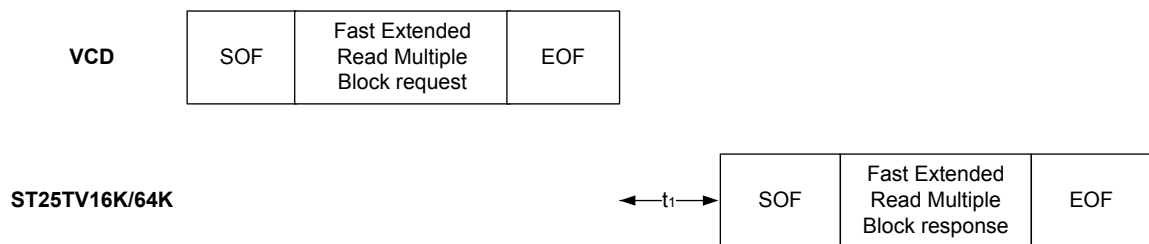
7 Unique identifier (UID)

The ST25TV16K/64K is uniquely identified by a 64-bit unique identifier (UID). This UID complies with ISO/IEC 15963 and ISO/IEC 7816-6. The UID is a read-only code and comprises:

- eight MSBs with a value of E0h,
- the IC manufacturer code "ST 02h" on 8 bits (ISO/IEC 7816-6/AM1),
- a unique serial number on 48 bits.

Table 144. UID format

MSB				LSB			
63	56	55	48	47	40	40	0
0xE0		0x02		ST product code [1]		Unique serial number	

1. See Table 27. UID for ST product code value definition.

With the UID, each ST25TV16K/64K can be addressed uniquely and individually during the anticollision loop and for one-to-one exchanges between a VCD and an ST25TV16K/64K.

8 Device parameters

8.1 Maximum rating

Stressing the device above the rating listed in Table 145. Absolute maximum ratings may cause permanent damage to the device. These are stress ratings only and operation of the device, at these or any other conditions above those indicated in the operating sections of this specification, is not implied. Exposure to absolute maximum rating conditions for extended periods may affect the device reliability. Refer also to the STMicroelectronics SURE Program and other relevant quality documents.

Table 145. Absolute maximum ratings

Symbol	Parameter		Min.	Max.	Unit
T_A	Ambient operating temperature		- 40	85	°C
T_{STG}	Storage Temperature	Sawn wafer on UV tape kept in its original packing form	15	25	°C
t_{STG}	Retain		-	9 [1]	months
V_{MAX_1} [2]	RF input voltage amplitude peak to peak between AC0 and AC1, V_{SS} pin left floating	V_{AC0} - V_{AC1}	-	11	V
V_{ESD}	Electrostatic discharge voltage [3] (human body model)	All pins	-	2000	V

1. *Counted from ST production date.*
2. *Based on characterization, not tested in production.*
3. *ANSI/ESDA/JEDEC JS-001-2012, C = 100 pF, R = 1500 Ω, R2 = 500 Ω*

8.2 RF electrical parameters

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

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

Table 146. RF characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
f_{CC}	External RF signal frequency		13.553	13.56	13.567	MHz
H_ISO	Operational field according to ISO	T_A= -40°C to 85°C	150	-	5000	mA/m
$MI_{CARRIER}$	10% carrier modulation index $MI=(A-B)/(A+B)$	150 mA/m > H_ISO > 1000 mA/m	10	-	30	%
	100% carrier modulation index	$MI=(A-B)/(A+B)$ [2]	95	-	100	
t_{MIN} CD	Minimum time from carrier generation to first data	From H-field min	-	-	1	ms
f_{SH}	Subcarrier frequency high	F_{CC}/32	-	423.75	-	kHz
f_{SL}	Subcarrier frequency low	F_{CC}/28	-	484.28	-	kHz
t_1	Time for ST25TV16K/64K response	$4352/F_C$	318.6	320.9	323.3	µs
t_2	Time between commands	$4192/F_C$	309	311.5	314	µs
t_3	Time between commands	$4384/F_C$	323.3	-	-	µs
W_{t_Block}	RF User memory write time (including internal Verify) [3]	1 Block	-	5.2	-	ms
		4 Blocks	-	19.7	-	ms
W_{t_Byte}	RF system memory write time including internal Verify) [3]	1 Byte	-	4.9	-	ms
$C_{TUN\_}$ 23.5pF	Internal tuning capacitor in SO8 [4]	f = 13.56 MHz	26.5	28.5	30.5	pF
V_{BACK} [4]	Backscattered level as defined by ISO test	-	10	-	-	mV
V_{MIN_1} [1]	RF input voltage amplitude between AC0 and AC1, V_{AC0}-V_{AC1} peak to peak[1]	Inventory and Read operations	-	4.8	-	Vpkpk
		Write operations	-	5.25	-	Vpkpk
t_{BootRF}	-	Set up time	-	0.6	-	ms
t_{RF_OFF}	RF OFF time	Chip reset	2	-	-	ms

1. *Characterized on bench.*

2. *Characterized at room temperature only, on wafer at POR Level.*

3. *For VCD request coded in 1 out of 4 and ST25TV16K/64K response in high data rate, single sub carrier.*

4. *The tuning capacitance value is measured with ST characterization equipment at chip Power On Reset. This value is used as reference for antenna design. Minimum and Maximum values come from correlation with industrial tester limits.*

Table 147. Operating conditions

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

Figure 37. ASK modulated signal shows an ASK modulated signal from the VCD to the ST25TV16K/64K. The test conditions for the AC/DC parameters are:

- Close coupling condition with tester antenna (1 mm)
- ST25TV16K/64K performance measured at the tag antenna
- ST25TV16K/64K synchronous timing, transmit and receive

Figure 37. ASK modulated signal
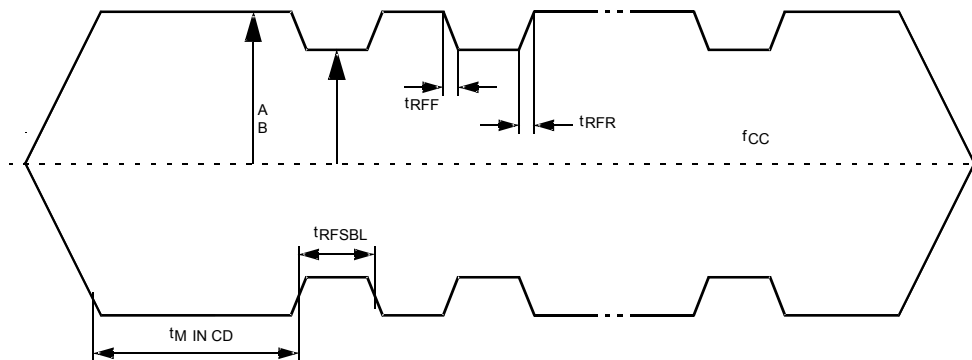
9 Ordering information

Table 148. Ordering information scheme

| Example: | ST25TV | 64K- | A | P | 6 | G | 3 |

Device type

ST25TV = NFC/RFID tag based on ISO 15693 and NFC T5T

Memory size

16K = 16 Kbits

64K = 64 Kbits

Interface

A = None

Features

P = Password as option

Device grade

6 = industrial: device tested with standard test flow over - 40 to 85 °C

Package

G = 120um +/- 15 um bumped sawn wafer

Capacitance

3 = 28.5 pF

Note: *Parts marked as "ES" or "E" are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering samples in production. ST's Quality department must be contacted prior to any decision to use these engineering samples to run a qualification activity.*

A Bit representation and coding for fast commands

Data bits are encoded using Manchester coding, according to the following schemes. For the low data rate, same subcarrier frequency or frequencies is/are used. In this case, the number of pulses is multiplied by 4 and all times increase by this factor. For the Fast commands using one subcarrier, all pulse numbers and times are divided by 2.

A.1 Bit coding using one subcarrier

A.1.1 High data rate

For the fast commands, a logic 0 starts with four pulses at 423.75 kHz (f_C/32) followed by an unmodulated time of 9.44 µs, as shown in Figure 38.

Figure 38. Logic 0, high data rate, fast commands
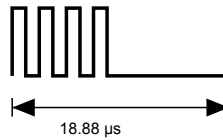
18.88 µs

For the Fast commands, a logic 1 starts with an unmodulated time of 9.44 µs followed by four pulses of 423.75 kHz (f_C/32), as shown in Figure 39 .

Figure 39. Logic 1, high data rate, fast commands

18.88 µs
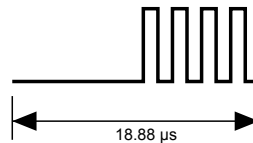
A.1.2 Low data rate

For the Fast commands, a logic 0 starts with 16 pulses at 423.75 kHz (f_C/32) followed by an unmodulated time of 37.76 µs, as shown in Figure 40.

Figure 40. Logic 0, low data rate, fast commands
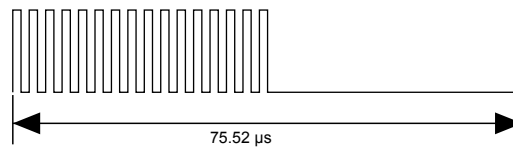
75.52 µs

For the Fast commands, a logic 1 starts with an unmodulated time of 37.76 µs followed by 16 pulses at 423.75 kHz (f_C/32), as shown in Figure 41.

Figure 41. Logic 1, low data rate, fast commands

75.52 µs
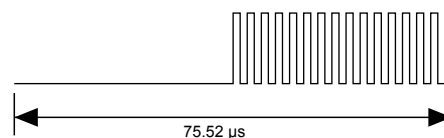
Note: *For fast commands, bit coding using two subcarriers is not supported.*

A.2 VICC to VCD frames

Frames are delimited by an SOF and an EOF. They are implemented using code violation. Unused options are reserved for future use. For the low data rate, the same subcarrier frequency or frequencies is/are used. In this case, the number of pulses is multiplied by 4. For the Fast commands using one subcarrier, all pulse numbers and times are divided by 2.

A.3 SOF when using one subcarrier

A.3.1 High data rate

For the Fast commands, the SOF comprises an unmodulated time of 28.32 µs, followed by 12 pulses at 423.75 kHz (f_C/32), and a logic 1 that consists of an unmodulated time of 9.44 µs followed by four pulses at 423.75 kHz, as shown in Figure 42. Start of frame, high data rate, one subcarrier, fast commands.

Figure 42. Start of frame, high data rate, one subcarrier, fast commands

56.64 µs   18.88 µs
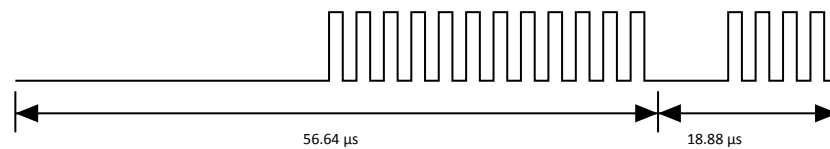
A.3.2 Low data rate

For the Fast commands, the SOF comprises an unmodulated time of 113.28 µs, followed by 48 pulses at 423.75 kHz (f_C/32), and a logic 1 that includes an unmodulated time of 37.76 µs followed by 16 pulses at 423.75 kHz, as shown in Figure 43.

Figure 43. Start of frame, low data rate, one subcarrier, fast commands

226.56 µs   75.52 µs
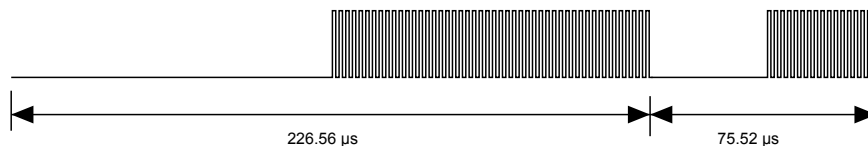
A.4 EOF when using one subcarrier

A.4.1 High data rate

For the Fast commands, the EOF comprises a logic 0 that includes four pulses at 423.75 kHz and an unmodulated time of 9.44 µs, followed by 12 pulses at 423.75 kHz (f_C/32) and an unmodulated time of 37.76 µs, as shown in Figure 44.

Figure 44. End of frame, high data rate, one subcarrier, fast commands

18.88 µs   56.64 µs
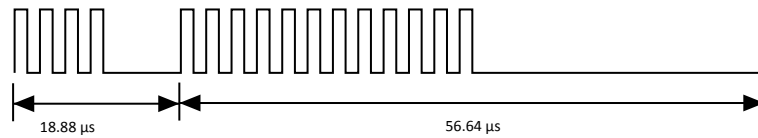
A.4.2 Low data rate

For the Fast commands, the EOF comprises a logic 0 that includes 16 pulses at 423.75 kHz and an unmodulated time of 37.76 µs, followed by 48 pulses at 423.75 kHz (f_C/32) and an unmodulated time of 113.28 µs, as shown in Figure 45.

Figure 45. End of frame, low data rate, one subcarrier, fast commands

75.52 µs   226.56 µs
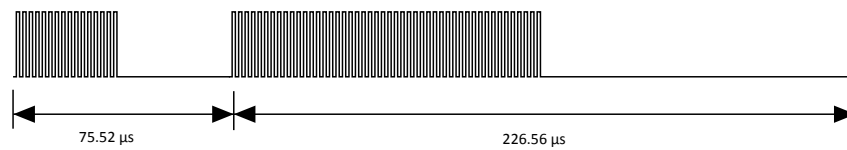
Note: *For SOF and EOF in fast commands, bit coding using two subcarriers is not supported.*

Revision history

Table 149. Document revision history

Date	Revision	Changes
27-Jan-2016	1	Initial release.
28-Apr-2016	2	Updated Figure 2: Memory sector organization and Figure 41: Stay Quiet frame exchange between VCD and ST25TV64K. Updated Table 27. UID. Updated Section 6.4.24 Get Multiple Block Security Status and Section 25.20: Fast Read Multiple Block.
11-Aug-2016	3	Added unsawn wafer option, hence updated Table 145. Absolute maximum ratings, Section 28: Ordering information and Table 148. Ordering information scheme. Updated Figure 36: ST25TV64K decision tree for AFI.
12-Apr-2017	4	Updated: • Features • Section 1 Description • Figure 1. ST25TV16K/64K block diagram • Section 2 Signal descriptions • Figure 2. ST25TV16K/64K RF power-up sequence • Section 3 Power management • Section 4 Memory management • Section 5 ST25TV16K/64K specific features • Section 6 RF Operations • Section 8 Device parameters • Section 9 Ordering information
30-Jun-2017	5	Updated: • Table 26. IC_REF • Table 27. UID • Table 94. Get System Info response format Error_flag is NOT set • Table 101. Response other field: ST25TV16K/64K IC Ref
05-Oct-2017	6	Updated: • Features • Section 5.2.4 System memory protection Added: • NFC certified logo

Date	Revision	Changes
18-Jul-2018	7	Added ST25TV16K device Updated: • Features • Section 1 Description • Section 4.2.1 User memory areas • Section 5.2.2 Passwords and security sessions • Section 6.4.28 Write Password • Figure 1. ST25TV16K/64K block diagram • Figure 3. Memory organization • Table 1. User memory as seen by RF • Table 2. Maximum user memory block addresses and ENDA$_i$ value • Table 4. ENDA1 • Table 5. ENDA2 • Table 6. ENDA3 • Table 24. MEM_SIZE • Table 100. Response other field: ST25TV16K/64K VICC memory size • Table 148. Ordering information scheme
14-Sep-2018	8	Updated: • Table 94. Get System Info response format Error_flag is NOT set • Section A.2 VICC to VCD frames

Contents

List of tables

List of figures

IMPORTANT NOTICE – PLEASE READ CAREFULLY