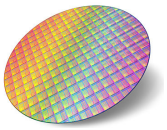
NFC Type 5 / RFID tag IC with 16-Kbit or 64-Kbit EEPROM and protection



Wafer

Product status link
ST25TV16KC
ST25TV64KC

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 four
- Internal tuning capacitance: 28.5 pF

Memory

- 16 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 at 25 °C
  - 600 k 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

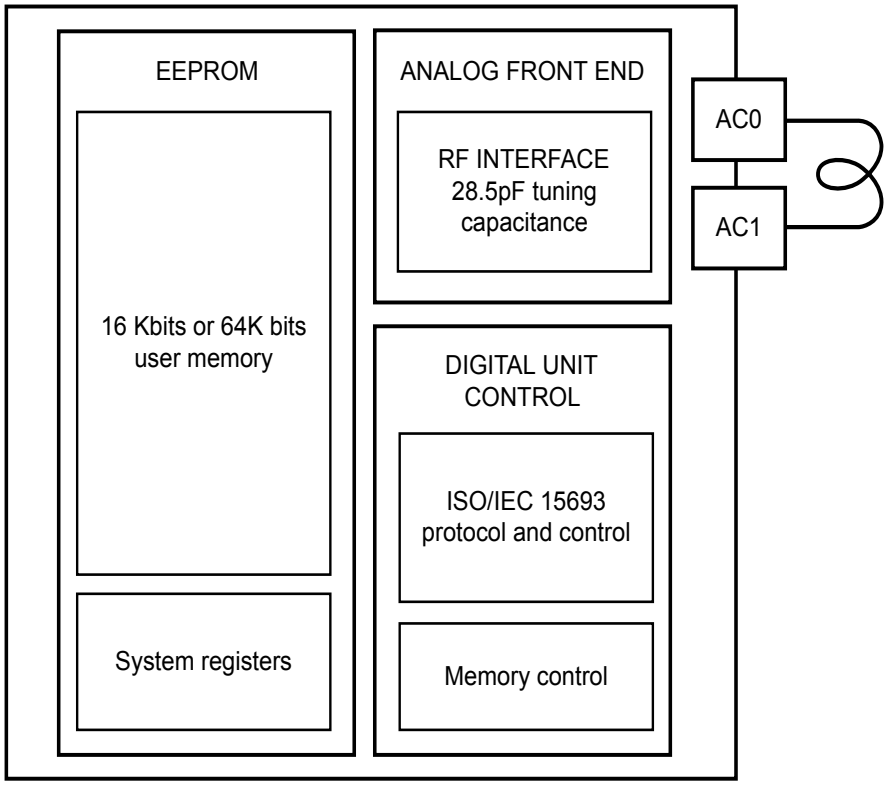
- From -40 to 85 °C

1 Description

The ST25TV16KC and ST25TV64KC devices are NFC and RFID tags, with, respectively, 16 and 64 Kbit of electrically erasable programmable memory (EEPROM). These devices act as a contactless memory accessed through an RF link, following ISO/IEC 15693 or NFC Forum Type 5 recommendations, and are powered by the received carrier electromagnetic wave.

1.1 Block diagram

Figure 1. Block diagram



2 Signal descriptions

2.1 Antenna coil (AC0, AC1)

These inputs are used exclusively to connect the ST25TV16KC/64KC 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

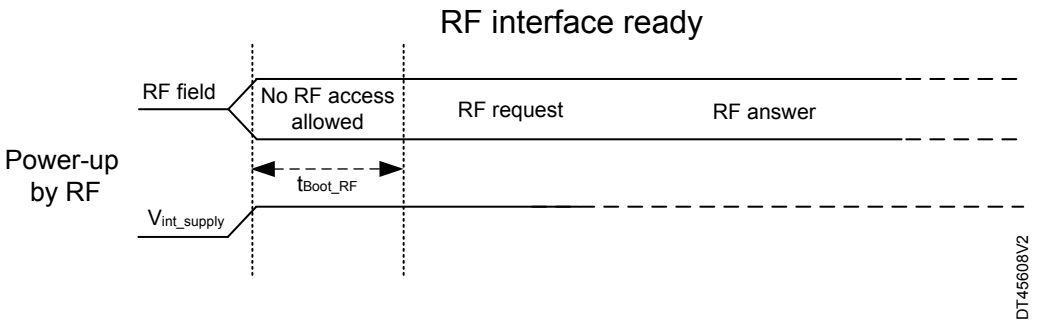
To ensure a proper boot of the RF circuitry, the RF field must be turned ON without any modulation for a minimum period of time (t_{BootRF}). Before this time, the device ignores all received RF commands (see Figure 2. RF power-up sequence).

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 period of time (t_{RF_OFF}).

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

Figure 2. RF power-up sequence



4 Memory management

4.1 Memory organization overview

The ST25TV16KC/64KC memory is divided in two main areas:

- User memory
- System configuration area

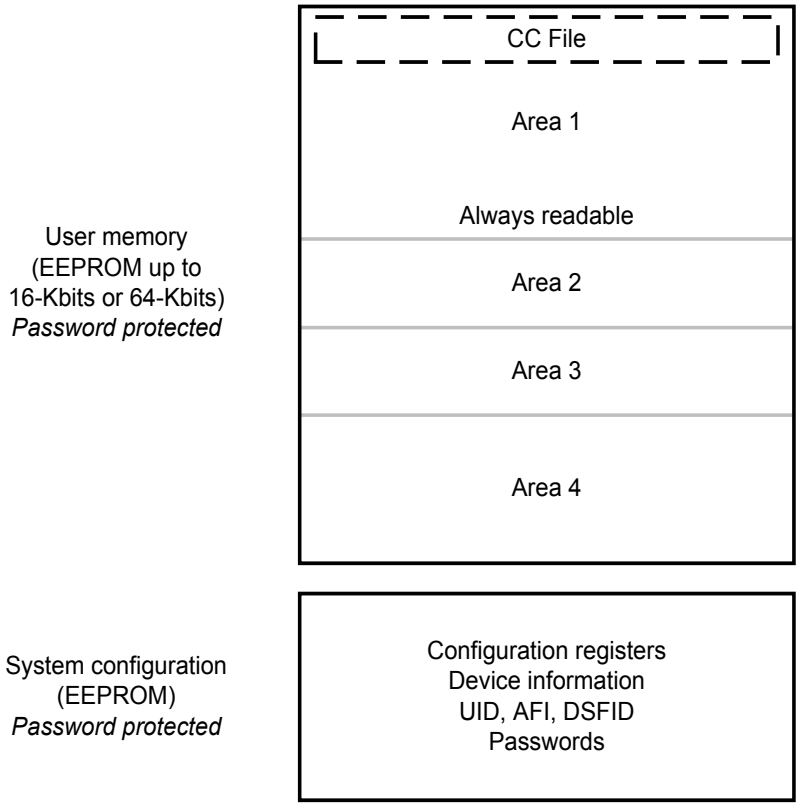
The user memory can be divided into four flexible areas, each can be individually read and/or write-protected with one out of three specific 64-bit passwords.

The system configuration area contains registers to configure the device 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 information such as IC reference, memory size, as well as a 64-bit block 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 an RF configuration password.

Figure 3. Memory organization



4.2 User memory

The 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 memory blocks, other read and write commands can address only up to block FFh. All blocks are initialized to 00h in the factory.

Table 1 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 00Bh	Byte 000Ah	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(3)			
	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.*
3. *Last block of user memory in ST25TV64KC.*

Note: In the factory all blocks of user memory are initialized to 00h.

4.2.1 User memory areas

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

RF write commands are legal only within a same area:

- Write multiple blocks and extended write multiple blocks command are not executed and return the error 0Fh if addresses cross an area border.

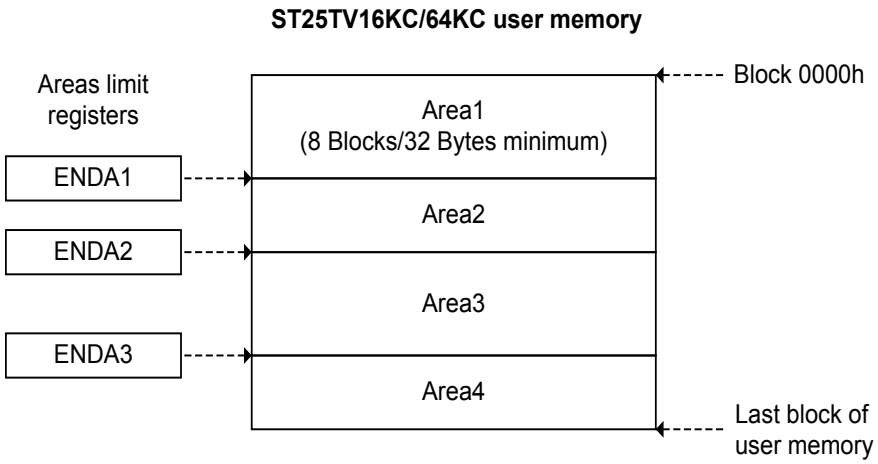
RF read commands are allowed over multiple areas:

- Read multiple blocks and extended read multiple blocks (and related fast commands) are executed and return all readable blocks until reaching a non readable block (address read protected or non available), even if addresses cross 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. User memory areas



On factory delivery all $ENDA_i$ are set to their maximum value, only Area1 exists, and includes the full user memory.

A granularity of 8 blocks (32 bytes) is offered to code the area ending points.

The area end limits are coded in $ENDA_i$ registers:

- Last block address of area = 8 x $ENDA_i$ + 7, hence $ENDA_i$ = int(Last $Area_i$ block address / 8)
- As a consequence, ENDA1 = 0 means that the 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
ST25TV16KC	01FFh	3Fh
ST25TV64KC	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

The organization has 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 can be defined by setting ENDA1 < ENDA2 = ENDA3 = End of user memory
- Three areas can be defined by setting ENDA1 < ENDA2 < ENDA3 = End of user memory
- A maximum of four areas can be defined by setting ENDA1 < ENDA2 < ENDA3 < End of user memory
- Area 1 specificities
  - Start is always Block address 0000h
  - Minimum size is 8 blocks (32 bytes) when ENDA1 = 00h
  - The area is always readable
- The last area always finishes on the last user memory Block address (ENDA4 does not exist).
- All areas are contiguous: end of Area(n) + one Block address is always start of Area(n+1).

Area size programming

The 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.

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, two 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 access

Command	Type
Read configuration (cmd code A0h) @05h Write configuration (cmd code A1h) @05h	R always, W if RF configuration security session is open and configuration not locked

Table 5. ENDA1

Bit	Name	Function	Factory value
b7-b0	ENDA1	End area 1 = 8*ENDA1+7 when expressed in blocks	ST25TV16KC: 3Fh ST25TV64KC: FFh

Note: Refer to Table 10 for the ENDA1 register.

Table 6. ENDA2 access

Command	Type
Read configuration (cmd code A0h) @07h Write configuration (cmd code A1h) @07h	R always, W if RF configuration security session is open and configuration not locked

Table 7. ENDA2

Bit	Name	Function	Factory value
b7-b0	ENDA2	End area 2 = 8 x ENDA2 + 7 when expressed in blocks	ST25TV16KC: 3Fh ST25TV64KC: FFh

Note: Refer to Table 10 for the ENDA2 register.

Table 8. ENDA3 access

Command	Type
Read configuration (cmd code A0h) @09h Write configuration (cmd code A1h) @09h	R always, W if RF configuration security session is open and configuration not locked

Table 9. ENDA3

Bit	Name	Function	Factory value
b7-b0	ENDA3	End area 3 = 8 x ENDA3 + 7 when expressed in blocks	ST25TV16KC: 3Fh ST25TV64KC: FFh

Note: Refer to Table 10 for the ENDA3 register.

4.3 System configuration area

In addition to the user memory, the devices include a set of registers located in the system configuration area (EEPROM nonvolatile registers). Those registers are set during device configuration (i.e.: area extension), or by the application (i.e.: area protection). The registers content is read during the boot sequence, and defines the basic ST25TV16KC/64KC 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 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 10 shows the complete map of the system configuration area.

Table 10. System configuration memory map

RF access		Static register	
Address	Type	Name	Function
03h	RW (1)	KILL	Tag kill
04h	RW(1)	A1SS	Area 1 access protection
05h	RW(1)	ENDA1	Area 1 ending point
06h	RW(1)	A2SS	Area 2 access protection
07h	RW(1)	ENDA2	Area 2 ending point
08h	RW(1)	A3SS	Area 3 access protection
09h	RW(1)	ENDA3	Area 3 ending point
0Ah	RW(1)	A4SS	Area 4 access protection
N/A	RW (2) (3)	LOCK_CCFILE	Blocks 0 and 1 RF Write protection
0Fh	RW(1)	LOCK_CFG	Protect Write to system configuration registers
N/A	WO (4)	LOCK_DSFID	DSFID lock status
NA	WO (5)	LOCK_AFI	AFI lock status
N/A	RW(4)	DSFID	DSFID value
N/A	RW(5)	AFI	AFI value
N/A	RO	MEM_SIZE	Memory size value in blocks, 2 bytes
	RO	BLK_SIZE	Block size value in bytes
N/A	RO	IC_REF	IC reference value
NA	RO	UID	Unique identifier, 8 bytes
N/A	WO (6)	PWD_0	Configuration security session password, 8 bytes
N/A	WO(6)	PWD_1	User security session password 1, 8 bytes
N/A	WO(6)	PWD_2	User security session password 2, 8 bytes
N/A	WO(6)	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 01h (see 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 ST25TV16KC/64KC specific features

The devices offer the data protection on user memory and system configuration, and a kill mode.

These features can be programmed by setting dedicated registers. The devices 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
- Device structure LOCK_CFG

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

Dedicated commands Read Configuration and Write Configuration must be used to access the configuration registers. Update is possible only 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 11. **Kill access**

Command	Type
Read configuration (command code A0h) @03h	R always, W if RF configuration security session is open and configuration not locked
Write configuration (command code A1h) @03h	

Table 12. **KILL**

Bit	Name	Function	Factory value
b0	KILL_ERROR	0: RF commands executed 1: ST25TV16KC/64KC is killed but still answers commands with error 0Fh	0b
b1	KILL_MUTE	0: RF communication enabled 1: ST25TV16KC/64KC is killed and does not answer to any command	0b
b7-b2	RFU	-	000000b

Note: Refer to Table 10 for the KILL register.

5.1.2 Kill mode description

KILL register allow the user to definitely kill the ST25TV16KC/64KC tag.

KILL register is composed of two bits (see Table 12): 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 ST25TV16KC/64KC:

- Kill mute mode:
  - When KILL_MUTE is set to 1, ST25TV16KC/64KC 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, ST25TV16KC/64KC 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, ST25TV16KC/64KC processes the request and respond accordingly.

5.2 Data protection

ST25TV16KC/64KC 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 13. A1SS access

Command	Type
Read configuration (cmd code A0h) @04h	R always, W if the configuration security session is open and configuration not locked
Write configuration (cmd code A1h) @04h	

Table 14. A1SS

Bit	Name	Function	Factory value
b1-b0	PWD_CTRL_A1	00: Area 1 user security session cannot 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 the user security session is open 10: Area 1 access: read always allowed, write allowed if the user security session is open 11: Area 1 access: read always allowed, write always forbidden	00b
b7-b4	RFU	-	0000b

Note: Refer to Table 10 for the A1SS register.

Table 15. A2SS access

Command	Type
Read configuration (cmd code A0h) @06h	R always, W if the configuration security session is open and configuration not locked
Write configuration (cmd code A1h) @06h	

Table 16. A2SS

Bit	Name	Function	Factory value
b1-b0	PWD_CTRL_A2	00: Area 2 user security session cannot 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 the 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 is allowed if the user security session is open, write always forbidden.	00b
b7-b4	RFU	-	0000b

Note: Refer to Table 10 for the A2SS register.

Table 17. A3SS access

Command	Type
Read configuration (cmd code A0h) @08h	R always, W if the RF configuration security session is open and configuration not locked
Write configuration (cmd code A1h) @08h	

Table 18. A3SS

Bit	Name	Function	Factory value
b1-b0	PWD_CTRL_A3	00: Area 3 user security session cannot 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 the 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 is allowed if the user security session is open, write always forbidden.	00b
b7-b4	RFU	-	0000b

Note: Refer to Table 10 for the A3SS register.

Table 19. A4SS access

Command	Type
Read configuration (cmd code A0h) @0Ah	R always, W if the configuration security session is open and configuration not locked
Write configuration (cmd code A1h) @0Ah	

Table 20. A4SS

Bit	Name	Function	Factory value
b1-b0	PWD_CTRL_A4	00: Area 4 user security session cannot 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 the 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 the user security session is open, write always forbidden	00b
b7-b4	RFU	-	0000b

Note: Refer to Table 10 for the A4SS register.

Table 21. LOCK_CCFILE access

Command	Type
Lock Block (cmd code 22h) @00h/01h	R always b0: W if block 00h is not already locked, b1: W if block 01h is not already locked.
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	

1. *With option flag set to 1.*

Table 22. LOCK_CCFILE

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

Note: Refer to Table 10 for the LOCK_CCFILE register.

Table 23. LOCK_CFG access

Command	Type
Read configuration (cmd code A0h) @0Fh	R always, W if the configuration security session is open and configuration not locked
Write configuration (cmd code A1h) @0Fh	

Table 24. LOCK_CFG

Bit	Name	Function	Factory value
b0	LCK_CFG	0: Configuration is unlocked 1: Configuration is locked	0b
b7-b1	RFU	-	0000000b

Note: Refer to Table 10 for the LOCK_CFG register.

Table 25. PWD_0 access

Command	Type
Present password (cmd code B3h)	WO if the configuration security session is open
Write password (cmd code B1h)	

Table 26. PWD_0

Bit	Name	Function	Factory value
b7-b0	PWD_0	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		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 10 for the PWD_0 register.

Table 27. PWD_1 access

Command	Type
Present password (cmd code B3h)	WO if the configuration security session is open with password 1
Write password (cmd code B1h)	

Table 28. PWD_1

Bit	Name	Function	Factory value
b7-b0	RF_PWD_1	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		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 10 for the PWD_1 register.

Table 29. PWD_2 access

Command	Type
Present password (cmd code B3h)	WO if the user security session is open with password 2
Write password (cmd code B1h)	

Table 30. PWD_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 10 for the PWD_2 register.

Table 31. PWD_3 access

Command	Type
Present password (cmd code B3h)	WO if user security session is open with password 3
Write password (cmd code B1h)	

Table 32. **PWD_3**

Bit	Name	Function	Factory value
b7-b0	PWD_3	Byte 0 (LSB) of password 3 for 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 10 for the PWD_3 register.

5.2.2 Passwords and security sessions

ST25TV16KC/64KC provides protection of user memory and system configuration registers. User 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 33.

Table 33. 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 (1) (PWD_1, PWD_2, PWD_3)	user access to protected user memory as defined in A_iSS registers user write access to password 1, 2 or 3(2)
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 ST25TV16KC/64KC 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.
- Present password command (code B3h): see Section 6.4.29.

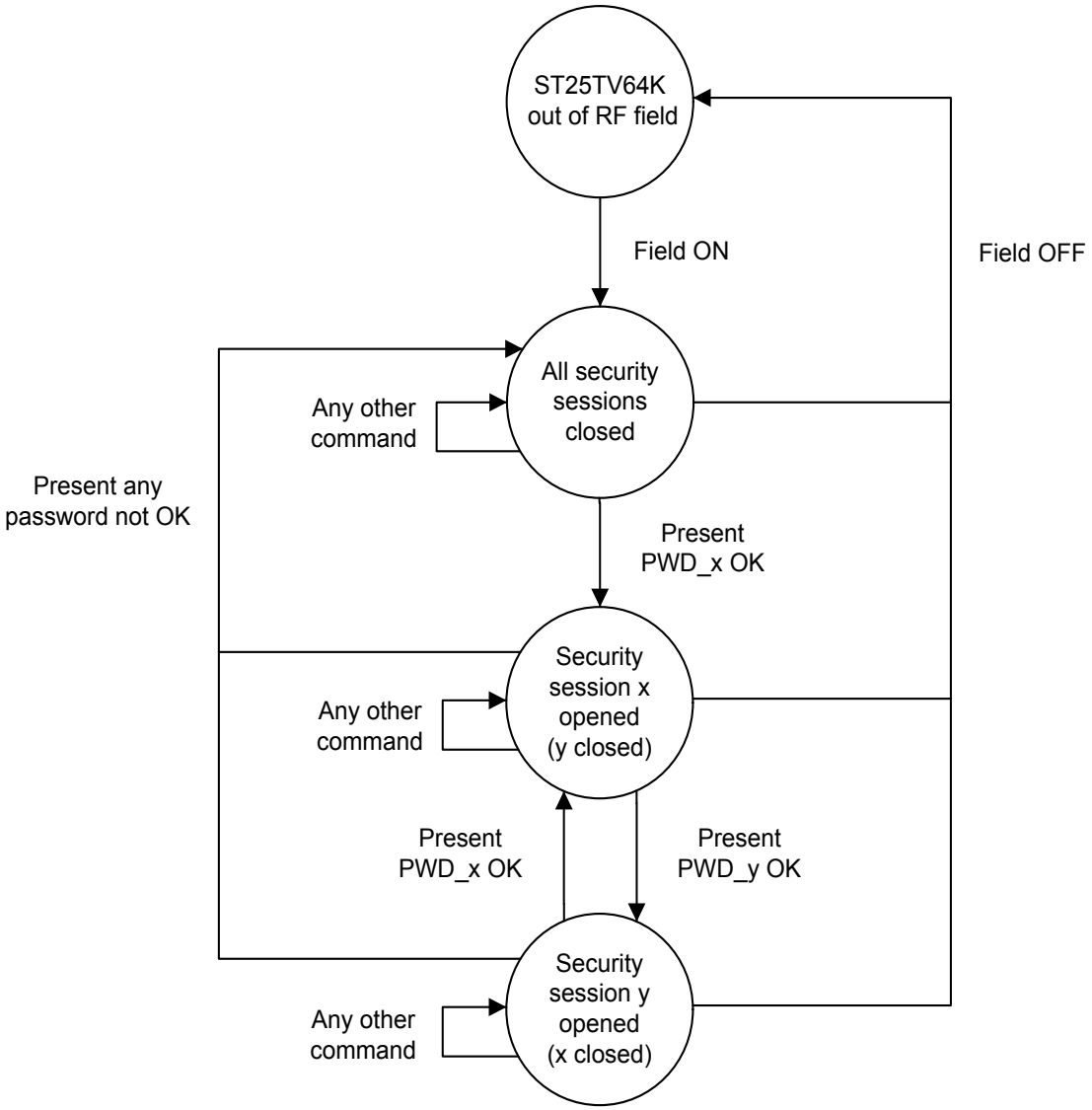
User possible actions for security sessions are:

- **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



Note: Presenting a password with an invalid password number doesn't close the session.

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 ST25TV16KC/64KC 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 A_iSS 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 14, Table 16, Table 18, and Table 20 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 A_iSS 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 (ENDA$_i$ registers), A$_i$SS 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

ST25TV16KC/64KC 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 34. LOCK_DSFID access

Command	Type
Lock DSFID (cmd code 2Ah)	WO if DSFID not locked

Table 35. LOCK_DSFID

Bit	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 10. System configuration memory map for the LOCK_DSFID register.

Table 36. LOCK_AFI access

Command	Type
Lock AFI (cmd code 28h)	WO if AFI not locked

Table 37. LOCK_AFI

Bit	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 10. System configuration memory map for the LOCK_AFI register.

Table 38. DSFID access

Command	Type
Inventory (cmd code 01h)	R always, W if DSFID not locked
Get System Info (cmd code 2Bh)	
Ext Get System Info (cmd code 3Bh)	
Write DSFID (cmd code 28h)	

Table 39. DSFID

Bit	Name	Function	Factory value
b7-b0	DSFID	ISO/IEC 15693 Data Storage Format Identifier	00h

Note: Refer to Table 10. System configuration memory map for the DSFID register.

Table 40. AFI access

Command	Type
Inventory (cmd code 01h)	R always, W if AFI not locked
Get System Info (cmd code 2Bh)	
Ext Get System Info (cmd code 3Bh)	
Write AFI (cmd code 27h)	

Table 41. AFI

Bit	Name	Function	Factory value
b7-b0	AFI	ISO/IEC 15693 Application Family Identifier	00h

Note: Refer to Table 10. System configuration memory map for the AFI register.

Table 42. MEM_SIZE access

Command	Type
Ext Get System Info (cmd code 3Bh)	RO

Table 43. MEM_SIZE

Bit	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	ST25TV16KC : 01h ST25TV64KC : 07h

Note: Refer to Table 10. System configuration memory map for the MEM_SIZE register.

Table 44. BLK_SIZE access

Command	Type
Ext Get System Info (cmd code 3Bh)	RO

Table 45. BLK_SIZE

Bit	Name	Function	Factory value
b7-b0	BLK_SIZE	user memory block size	03h

Note: Refer to Table 10. System configuration memory map for the BLK_SIZE register.

Table 46. IC_REF access

Command	Type
Get System Info (cmd code 2Bh)	RO
Ext Get System Info (cmd code 3Bh)	

Table 47. IC_REF

Bit	Name	Function	Factory value
b7-b0	IC_REF	ISO/IEC 15693 IC Reference	ST25TV16KC : 49h ST25TV64KC : 49h

Note: Refer to Table 10. System configuration memory map for the IC_REF register.

Table 48. UID access

Command	Type
Inventory (cmd code 01h)	RO
Get System Info (cmd code 2Bh)	
Ext Get System Info (cmd code 3Bh)	

Table 49. UID

Bit	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	ST25TV16KC : 49h ST25TV64KC : 49h
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 10. System configuration memory map for the UID register.

6 RF operation

Contactless exchanges are performed as specified by ISO/IEC 15693 or NFC Forum Type 5. The devices communicate 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 load variation using Manchester coding with one or two subcarrier frequencies at 423 kHz and 484 kHz. Data are transferred from the device at 6.6 Kbit/s in low data rate mode, at 26 Kbit/s in high data rate mode. The devices support the 53 Kbit/s in high data rate mode in one sub-carrier frequency at 423 kHz.

The ST25TV16KC/64KC follow ISO/IEC 15693 or NFC Forum Type 5 recommendation for radio-frequency power and signal interface, and for anticollision and transmission protocols.

6.1 RF communication

6.1.1 Access to an ISO/IEC 15693 device

The dialog between the “reader” and the ST25TV16KC/64KC takes place as follows:

- Activation of the device by the operating field of the reader,
- Transmission of a command by the reader (the device detects carrier amplitude modulation)
- Transmission of a response by the device using load modulation)

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).

Operating field

The ST25TV16KC/64KC operates continuously between the minimum and maximum values of the electromagnetic field H defined in Table 1. The reader has to generate a field within these limits.

Power transfer

Power is transferred to the ST25TV16KC/64KC by radio frequency at 13.56 MHz via coupling antennas in the ST25TV16KC/64KC and the reader. The operating field of the reader is transformed on the ST25TV16KC/64KC 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 ST25TV16KC/64KC acts as the VICC.

This means that a ST25TV16KC/64KC 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:

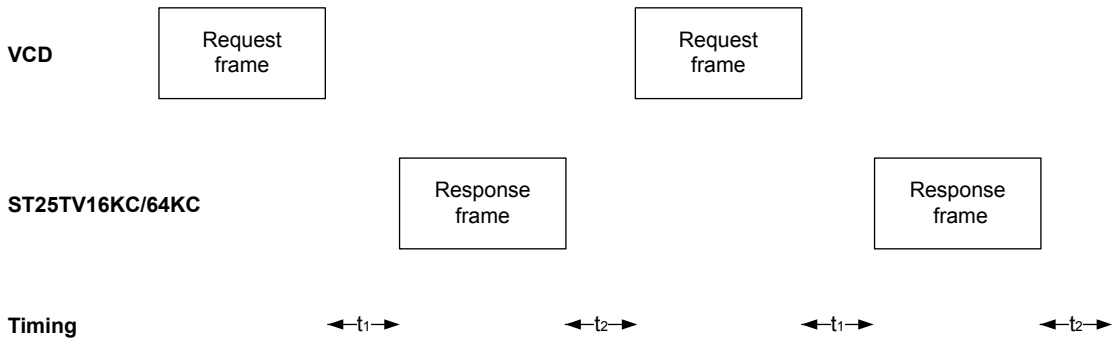
- a request from the VCD to the ST25TV16KC/64KC,
- a response from the ST25TV16KC/64KC to the VCD.

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. ST25TV16KC/64KC protocol timing



6.2.2 ST25TV16KC/64KC states referring to protocol

The ST25TV16KC/64KC can be in one of four states:

- Power-off
- Ready
- Quiet
- Selected

Transitions between these states are specified in Figure 7 and Table 50.

Power-off state

The device is in the power-off state when it does not receive enough energy from the VCD.

Ready state

The device is in the Ready state when it receives enough energy from the VCD. In this state, the device answers any request where the Select_flag is not set.

Quiet state

When in this state, the device answers any request with the Address_flag set, except for Inventory requests.

Selected state

In the selected state, the device answers requests, in all modes (see Modes):

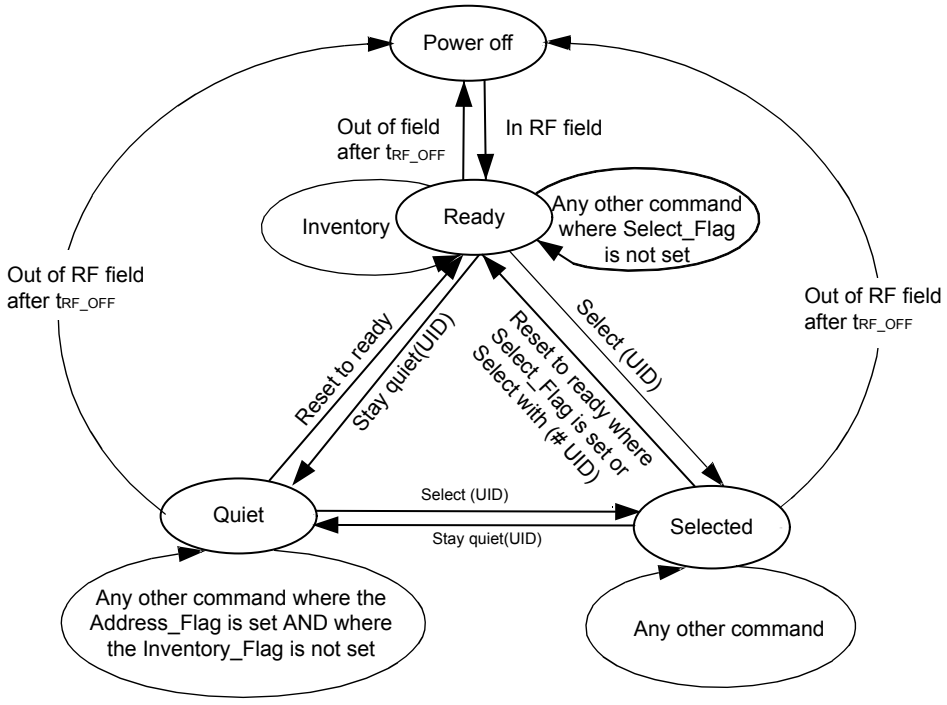
- Request in select mode with the Select_flag set
- Request in addressed mode if the UID matches
- Request in non-addressed mode (the mode for general requests)

Table 50. Device response (depending on Request_flags)

Flags	Address_flag		Select_flag	
	1 Addressed	0 Non addressed	1 Selected	0 Non selected
Device in ready or selected state (Devices in quiet state do not answer)	-	X	-	X
Device in selected state	-	X	X	-

Flags	Address_flag		Select_flag	
	1 Addressed	0 Non addressed	1 Selected	0 Non selected
Device in ready, quiet or selected state (the device matching the UID)	X	-	-	X
Error (03h) or no response (command dependent)	X	-	X	-

Figure 7. State transition diagram



Note: The device 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 to have only one ST25TV16KC/64KC in the selected state at any given time.

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

When the Address_flag is set to 0, the request must 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 ST25TV16KC/64KC 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 ST25TV16KC/64KC.

Any ST25TV16KC/64KC that receives a request with the Address_flag set to 1 compares the received Unique ID to its own. If it matches, then the ST25TV16KC/64KC 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 ST25TV16KC/64KC 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 ST25TV16KC/64KC in the Selected state answers a request where the Select_flag is set to 1.

The system design ensures that only one ST25TV16KC/64KC 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 51. 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 ST25TV16KC/64KC 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 ST25TV16KC/64KC selection criteria. When bit 3 is set (1), bits 5 to 8 define the ST25TV16KC/64KC Inventory parameters.

Table 52. 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 ST25TV16KC/64KC
		1	Two subcarriers are used by the ST25TV16KC/64KC
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 53
		1	The meaning of flags 5 to 8 is described in Table 53
Bit 4	Protocol_extension_flag	0	No protocol format extension
		1	Protocol format extension. Reserved for future use.

1. *Subcarrier_flag refers to the ST25TV16KC/64KC-to-VCD communication.*
2. *Data_rate_flag refers to the ST25TV16KC/64KC-to-VCD communication.*

Table 53. 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 ST25TV16KC/64KC according to the setting of Address_flag
		1	The request is executed only by the ST25TV16KC/64KC in Selected state
Bit 6	Address flag	0	The request is not addressed. UID field is not present. The request is executed by all ST25TV16KC/64KCs.
		1	The request is addressed. UID field is present. The request is executed only by the ST25TV16KC/64KC 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 54. 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 55. 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 ST25TV16KC/64KC and whether corresponding fields are present or not. The response flags consist of eight bits.

Table 56. 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 ST25TV16KC/64KC in the response, the Error code field is present and provides information about the error that occurred.

Error codes not specified in Table 57 are reserved for future use.

Table 57. 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: ST25TV16KC/64KC response delay

Upon detection of the rising edge of the EOF received from the VCD, the ST25TV16KC/64KC 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 58.

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 ST25TV16KC/64KC responses have been received during an Inventory command. It starts from the reception of the EOF from the ST25TV16KC/64KCs.

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 ST25TV16KC/64KC.

t_2 is also the time after which the VCD may send a new request to the ST25TV16KC/64KC, as described in Figure 6.

Values of t_2 are given in Table 58.

t_3: VCD new request delay when no response is received from the ST25TV16KC/64KC

t_3 is the time after which the VCD may send an EOF to switch to the next slot when no ST25TV16KC/64KC 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 ST25TV16KC/64KC.

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 58. 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 ST25TV16KC/64KC 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 ST25TV16KC/64KC. t_{NRT} depends on VICC to ST25TV16KC/64KC 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 ST25TV16KC/64KC supports the following legacy and extended RF command set:

- **Inventory**, used to perform the anticollision sequence.
- **Stay quiet**, used to put the ST25TV16KC/64KC in quiet mode, where it does not respond to any inventory command.
- **Select**, used to select the ST25TV16KC/64KC. After this command, the ST25TV16KC/64KC processes all read/write commands with Select_flag set.
- **Reset to ready**, used to put the ST25TV16KC/64KC 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 ST25TV16KC/64KC supports the commands described in this section. Their codes are given in Table 59.

Table 59. Command codes

Command code standard	Function	Command code custom	Function
01h	Inventory	A0h	Read configuration
02h	Stay quiet	A1h	Write configuration
20h	Read single block	B1h	Write password
21h	Section 6.4.8 Write single block	B3h	Present password
22h	Lock block	C0h	Fast read single block
23h	Read multiple blocks	C3h	Fast read multiple blocks
24h	Write multiple blocks	C4h	Fast extended read single block
25h	Select	C5h	Fast extended read multiple block
26h	Reset to ready	-	-
27h	Write AFI	-	-
28h	Lock AFI	-	-
29h	Write DSFID	-	-
2Ah	Lock DSFID	-	-
2Bh	Get system info	-	-
2Ch	Get multiple block security status	-	-
30h	Extended read single block	-	-
31h	Extended write single block	-	-
32h	Extended lock block	-	-
33h	Extended read multiple blocks	-	-
34h	Extended write multiple blocks	-	-
3Bh	Extended get system info	-	-
3Ch	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 ST25TV16KC/64KC 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 ST25TV16KC/64KC runs the anticollision sequence. The inventory_flag is set to 1. The meaning of flags 5 to 8 is shown in Table 61.

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 ST25TV16KC/64KC does not generate any answer in case of error.

Table 60. 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 61. 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 ST25TV16KC/64KC 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 ST25TV16KC/64KC to transmit an SOF to the VCD,
- t_{NRT} is the nominal response time of the ST25TV16KC/64KC.

t_{NRT} and t_{SOF} are dependent on the ST25TV16KC/64KC to VCD data rate and subcarrier modulation mode.

Note: In case of error, no response is sent by ST25TV16KC/64KC.

6.4.5 Stay quiet

On receiving the stay quiet command, the ST25TV16KC/64KC 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 ST25TV16KC/64KC does not process any request if the Inventory_flag is set,
- the ST25TV16KC/64KC processes any addressed request.

The ST25TV16KC/64KC exits the quiet state when:

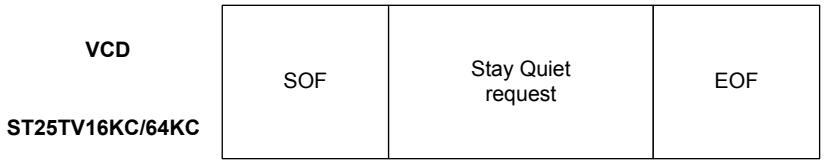
- it is reset (power off),
- receiving a select request. It then goes to the selected state,
- receiving a reset to ready request. It then goes to the ready state.

Table 62. **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 ST25TV16KC/64KC**



6.4.6 Read single block

On receiving the read single block command, the ST25TV16KC/64KC 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 ST25TV16KC/64KC can be addressed using this command.

Table 63. **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 64. **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 65)
- Four bytes of block data

Table 65. **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

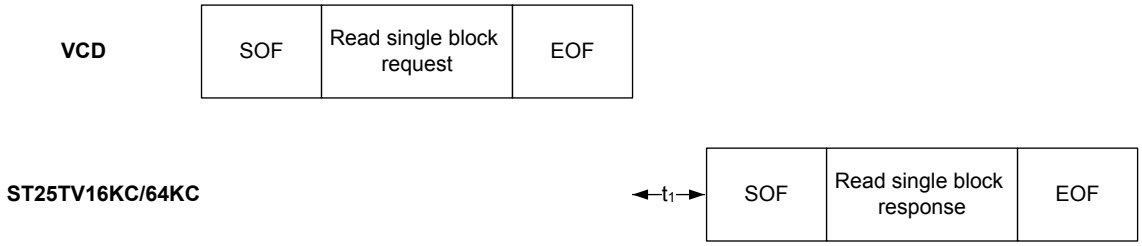
Table 66. Read single block response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.7 Extended read single block

On receiving the extended read single block command, the ST25TV16KC/64KC 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 ST25TV16KC/64KC can be addressed using this command.

Table 67. 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 68. 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 3)

- Four bytes of block data

Table 69. 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

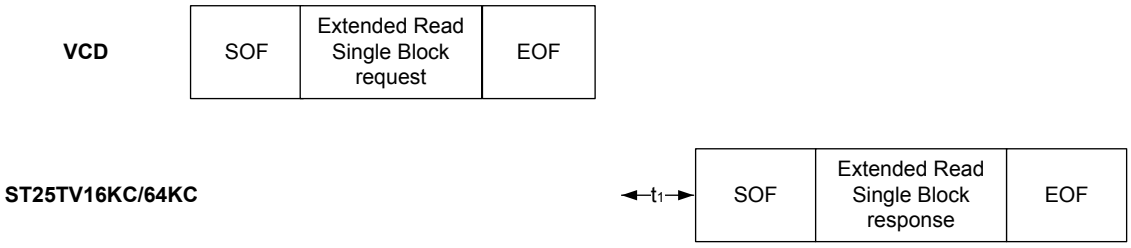
Table 70. Extended read single block response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.8 Write single block

On receiving the write single block command, the ST25TV16KC/64KC 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 ST25TV16KC/64KC 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 ST25TV16KC/64KC can be addressed using this command.

Table 71. 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 72. 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 73. Write single block response format when Error_flag is set

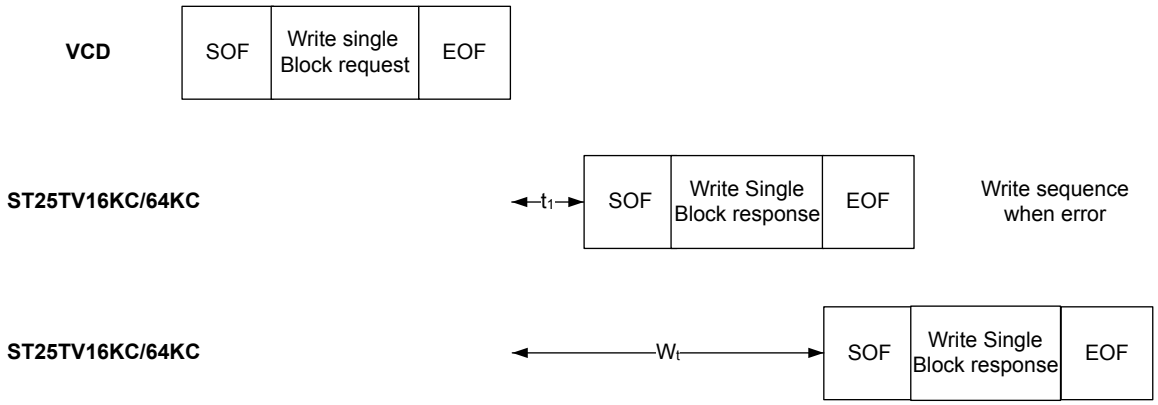
Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-

Response parameter:

- Error code as Error_flag is set
  - 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*

Figure 11. Write single block frame exchange between VCD and ST25TV16KC/64KC



6.4.9 Extended write single block

On receiving the extended write single command, the ST25TV16KC/64KC 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 ST25TV16KC/64KC 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 ST25TV16KC/64KC can be addressed using this command.

Table 74. 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 75. 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.

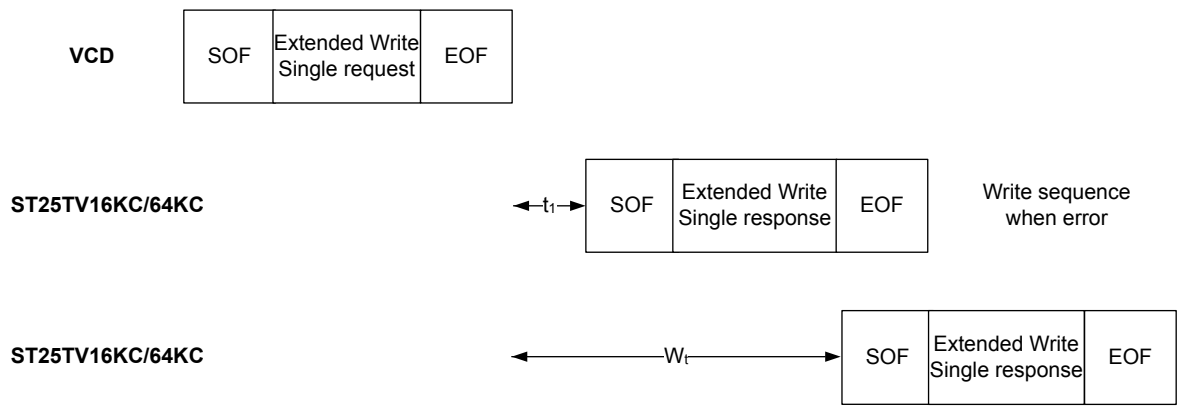
Table 76. Extended write single response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.10 Lock block

On receiving the lock block request, the ST25TV16KC/64KC 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 ST25TV16KC/64KC 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 77. 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 78. 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

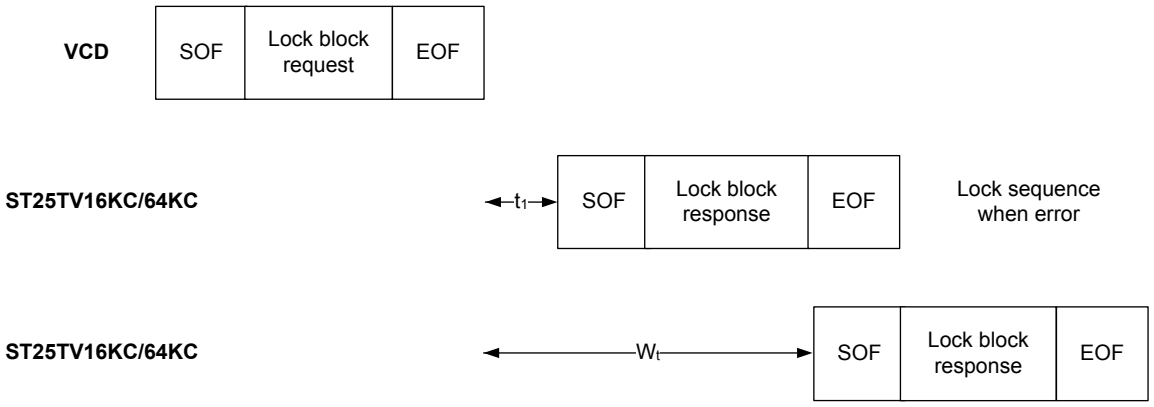
Table 79. Lock single block response format when Error_flag is set

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 ST25TV16KC/64KC**



6.4.11 Extended lock block

On receiving the extended Lock block request, the ST25TV16KC/64KC 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 ST25TV16KC/64KC 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 80. **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 81. **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

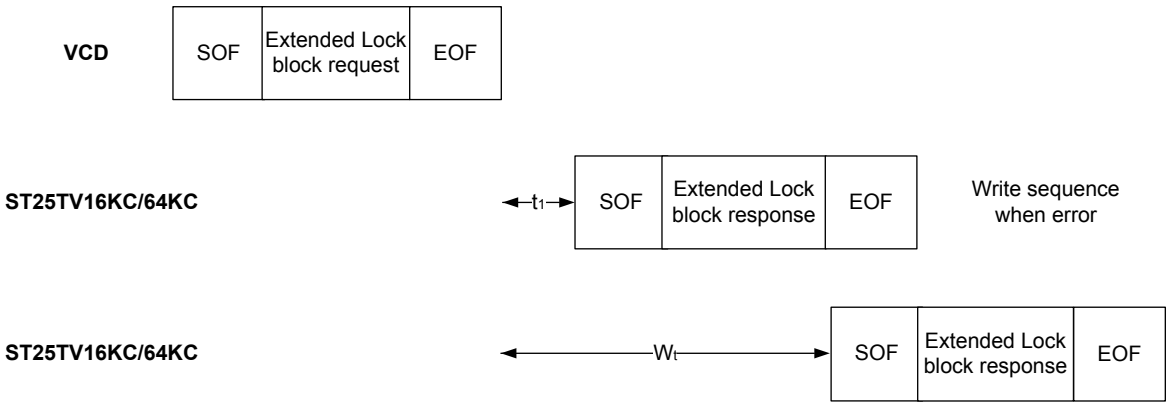
Table 82. **Extended lock block response format when Error_flag is set**

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 ST25TV16KC/64KC



6.4.12 Read multiple blocks

When receiving the read multiple block command, the ST25TV16KC/64KC 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. Read multiple blocks command can cross areas borders, and returns all blocks until reaching a non readable block (block read protected or out of memory). 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 ST25TV16KC/64KC can be addressed using this command.

Table 83. 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 84. 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 85. Block security status)
- N blocks of data

Table 85. 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

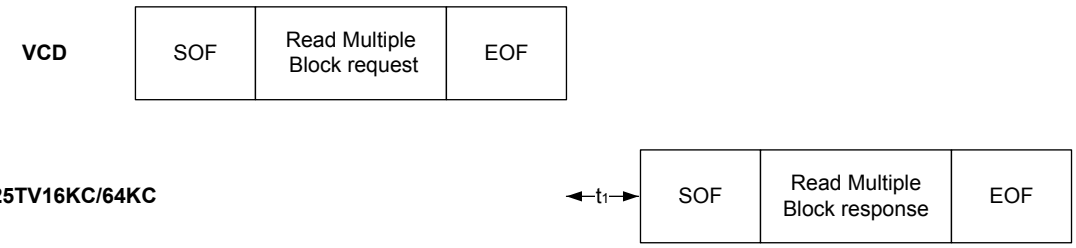
Table 86. Read multiple block response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.13 Extended read multiple blocks

When receiving the extended read multiple block command, the ST25TV16KC/64KC 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. Extended Read Multiple Blocks command can cross areas borders, and returns all blocks until reaching a non readable block (block read protected or out of memory). 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 ST25TV16KC/64KC can be addressed using this command.

Table 87. 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 88. 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 3)
- N blocks of data

Table 89. 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

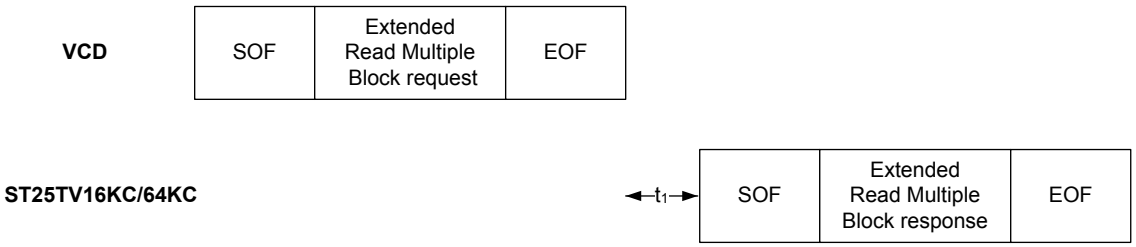
Table 90. Extended read multiple block response format when Error_flag is set

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 ST25TV16KC/64KC**



6.4.14 Write multiple blocks

On receiving the write multiple block command, the ST25TV16KC/64KC writes the data contained in the request to the requested blocks, and reports whether the write operation were successful in the response. ST25TV16KC/64KC supports up to 4 blocks, data field must be coherent with the number of blocks to program.

The number of blocks in the request is one less than the number of blocks that the ST25TV16KC/64KC shall write (for instance number of block = 2 means 3 blocks to be written).

If some blocks overlaps areas, or overlap end of user memory the ST25TV16KC/64KC 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 W_t, there should be no modulation (neither 100% nor 10%), otherwise the ST25TV16KC/64KC may not program correctly the data into the memory. The W_t time is equal to t_{1nom} + m × 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 ST25TV16KC/64KC can be addressed using this command.

Table 91. **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 92. **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.

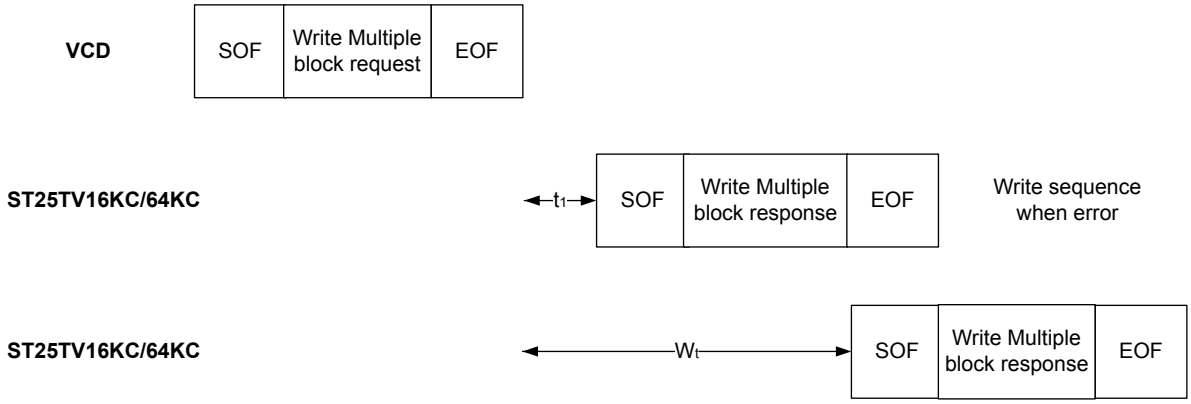
Table 93. Write multiple block response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.15 Extended write multiple blocks

On receiving the extended write multiple block command, the ST25TV16KC/64KC writes the data contained in the request to the targeted blocks and reports whether the write operation were successful in the response. ST25TV16KC/64KC supports up to 4 blocks, data field must be coherent with number of blocks to program.

The number of blocks in the request is one less than the number of blocks that the ST25TV16KC/64KC shall write (for instance number of block = 2 means 3 blocks to be written).

If some blocks overlaps areas, or overlap end of user memory the ST25TV16KC/64KC 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 ST25TV16KC/64KC may not program correctly the data into the memory. The W_t time is equal to t_{1nom} + m × 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 ST25TV16KC/64KC can be addressed using this command.

Table 94. 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 95. 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.

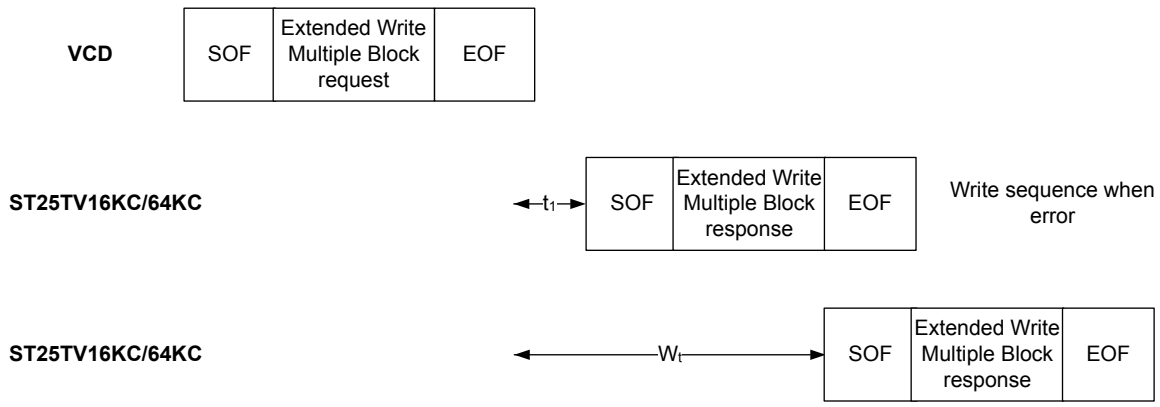
Table 96. Extended write multiple block response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.16 Select

When receiving the select command:

- If the UID is equal to its own UID, the ST25TV16KC/64KC enters or stays in the selected state and sends a response.

- If the UID does not match its own UID, the selected ST25TV16KC/64KC returns to the ready state and does not send a response.

The ST25TV16KC/64KC 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 ST25TV16KC/64KC remains in its current state.

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

Table 97. Select request format

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

Request parameter:

- UID

Table 98. 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

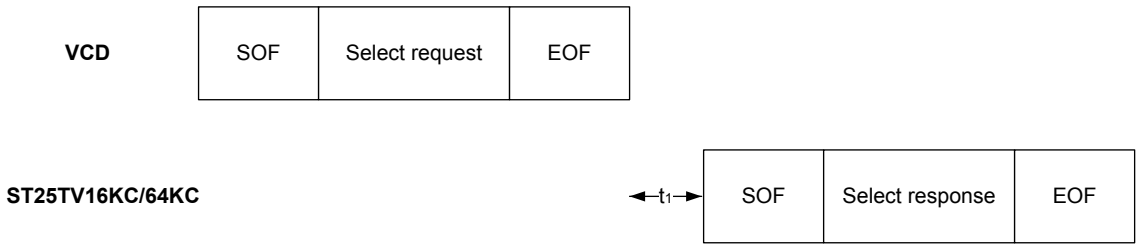
Table 99. Select response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.17 Reset to ready

On receiving a reset to ready command, the ST25TV16KC/64KC returns to the ready state if no error occurs. In the addressed mode, the ST25TV16KC/64KC 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 100. 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 101. 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

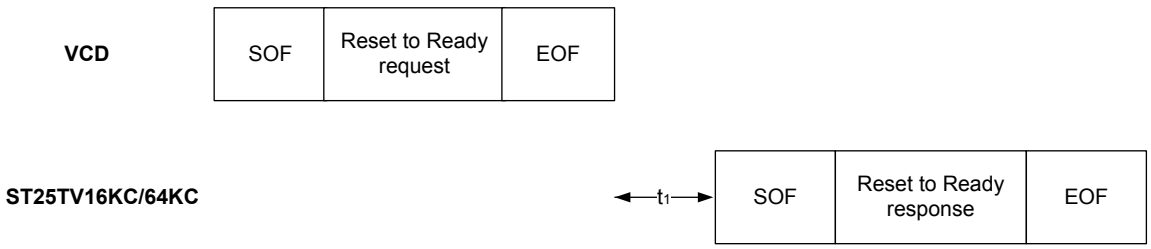
Table 102. Reset to ready response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.18 Write AFI

On receiving the write AFI request, the ST25TV16KC/64KC 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 ST25TV16KC/64KC 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 103. 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 104. 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

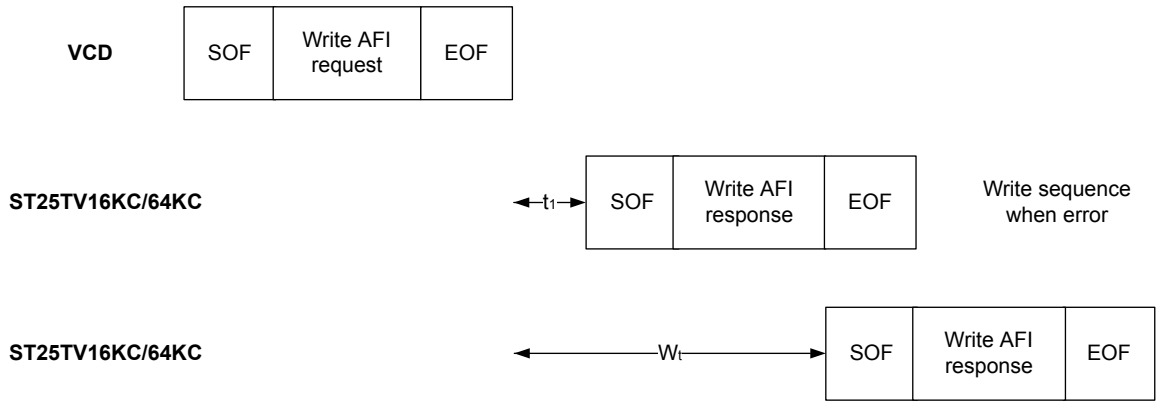
Table 105. Write AFI response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.19 Lock AFI

On receiving the lock AFI request, the ST25TV16KC/64KC 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 ST25TV16KC/64KC may not lock correctly the AFI value in memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Table 106. 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 107. 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

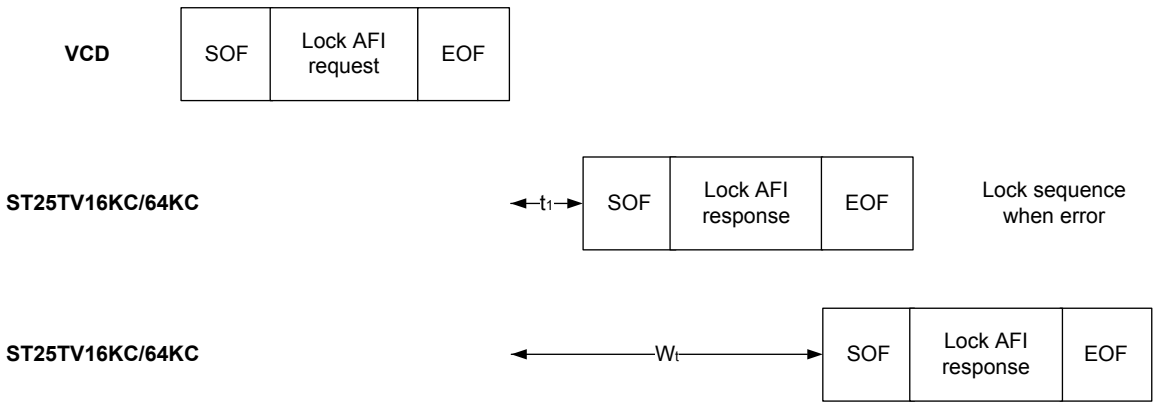
Table 108. Lock AFI response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.20 Write DSFID

On receiving the Write DSFID request, the ST25TV16KC/64KC 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 ST25TV16KC/64KC 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 109. 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 110. 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

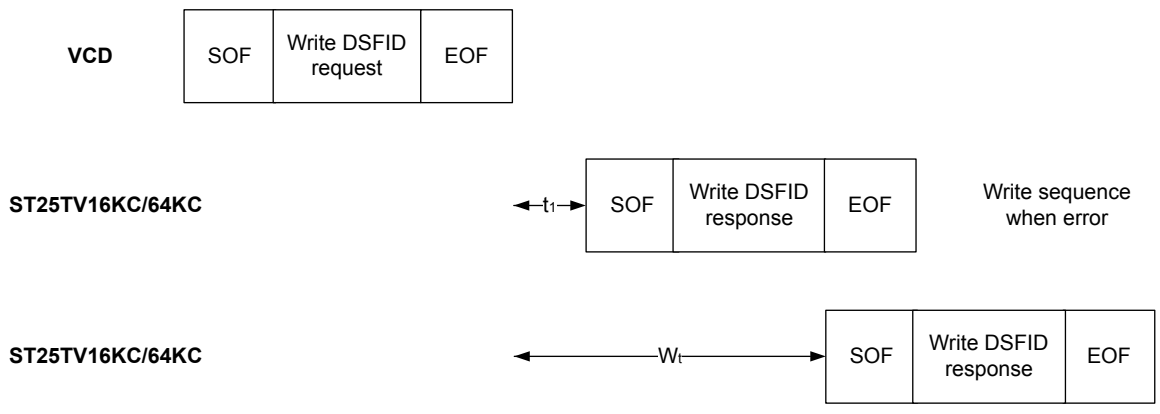
Table 111. Write DSFID response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.21 Lock DSFID

On receiving the lock DSFID request, the ST25TV16KC/64KC 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 ST25TV16KC/64KC may not lock correctly the DSFID value in memory. The W_t time is equal to t_{1nom} + N × 302 µs (N is an integer).

Table 112. 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 113. 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.

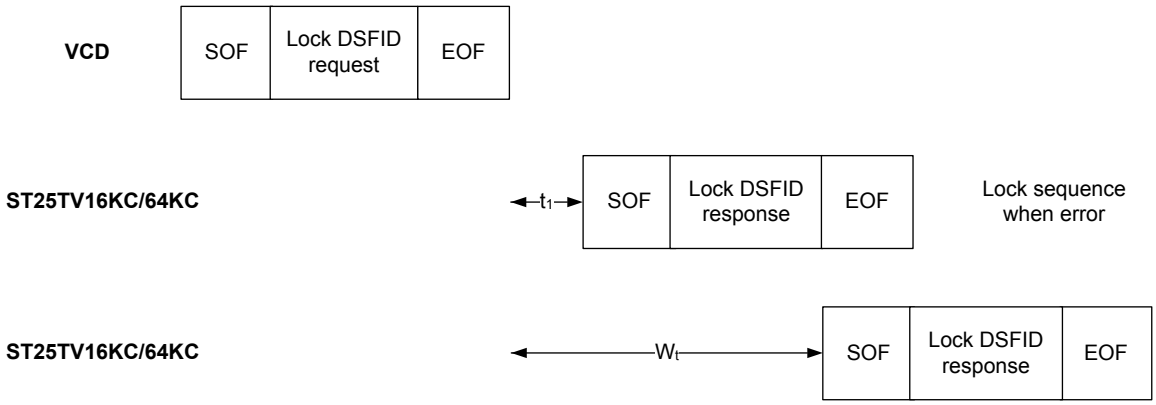
Table 114. Lock DSFID response format when Error_flag is set

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 ST25TV16KC/64KC**



6.4.22 Get system info

When receiving the get system info command, the ST25TV16KC/64KC 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 115. **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 116. **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	0Bh	64bits	8 bits	8 bits	49h	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.

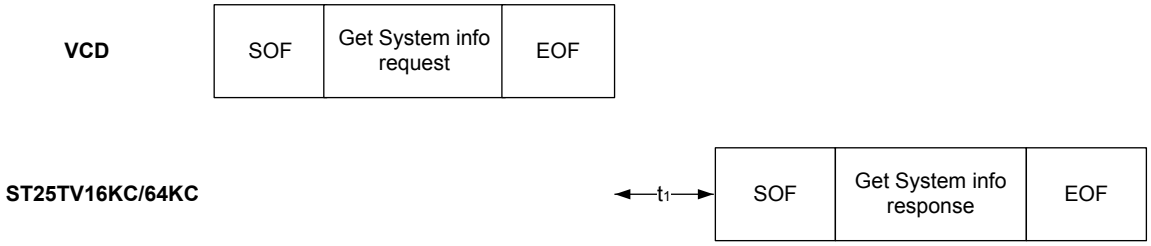
Table 117. **Get system info response format when Error_flag is set**

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 ST25TV16KC/64KC



6.4.23 Extended get system info

When receiving the extended get system info command, the ST25TV16KC/64KC 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 118. 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)

Table 119. Parameter request list

Bit	Flag name	Value	Description
b1	DSFID	0	No request of DSFID
		1	Request of DSFID
b2	AFI	0	No request of AFI
		1	Request of AFI
b3	V_{ICC} memory size	0	No request of data field on V_{ICC}memory size
		1	Request of data field on V_{ICC} memory 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	V_{ICC} 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 120. 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 4.*
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:
  - V_{ICC} memory size (if requested in parameters request field)
  - ICRef (if requested in parameters request field)
  - V_{ICC} command list (if requested in parameters request field)

Table 121. 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	V_{ICC} memory size	0	Data field on V_{ICC} memory size is not present.
		1	Data field on V_{ICC} memory size is present.
b4	IC reference	0	Information on IC reference field is not present.
		1	Information on IC reference field is present.
b5	MOI	1	2-byte addressing
b6	V_{ICC} command list	0	Data field of all supported command is not present
		1	Data field of all supported command is present
b7	CSI Information	0	CSI list is not present
b8	Info flag field	0	One byte length of info flag field

Table 122. Response other field: ST25TV16KC/64KC VICC memory size

MSB					LSB
24	22	21	17	16	01
RFU		Block size in byte		Number of blocks	
0h		03h		ST25TV16KC	01FFh
				ST25TV64KC	07FFh

Table 123. Response other field: ST25TV16KC/64KC IC Ref

1 byte
ICRef
49h

Table 124. Response other field: ST25TV16KC/64KC V_{ICC} 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 125. Response other field: ST25TV16KC/64KC V_{ICC}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 126. Response other field: ST25TV16KC/64KC V_{ICC} 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 127. Response other field: ST25TV16KC/64KC V_{ICC} 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 128. Response other field: ST25TV16KC/64KC V_{ICC} 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

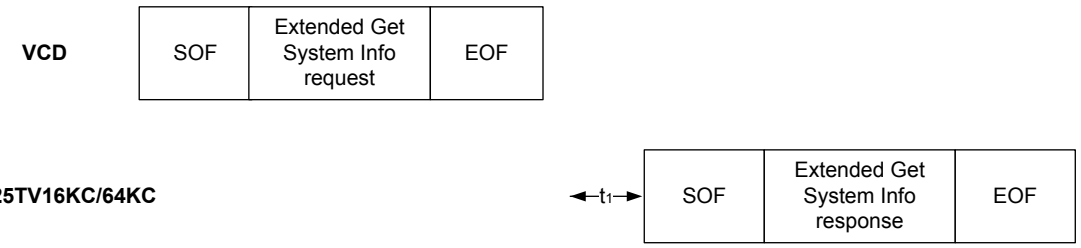
Table 129. Extended get system info response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.24 Get multiple block security status

When receiving the get multiple block security status command, the ST25TV16KC/64KC 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 ST25TV16KC/64KC can be addressed using this command.

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

Table 130. 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 131. 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 132. 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

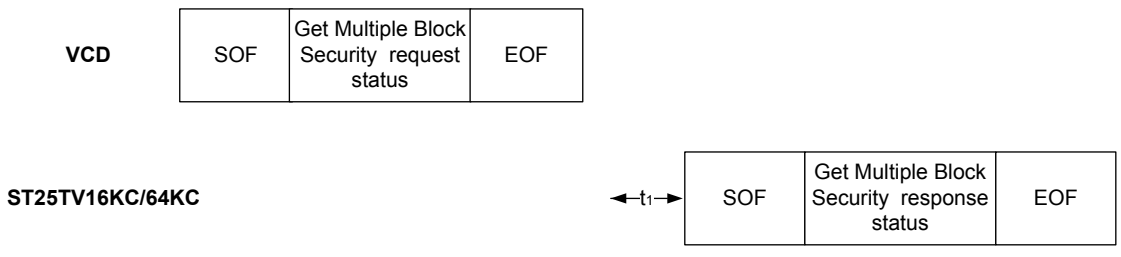
Table 133. Get multiple block security status response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.25 Extended get multiple block security status

When receiving the extended get multiple block security status command, the ST25TV16KC/64KC 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 ST25TV16KC/64KC can be addressed using this command.

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

Table 134. 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 135. 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 136. 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

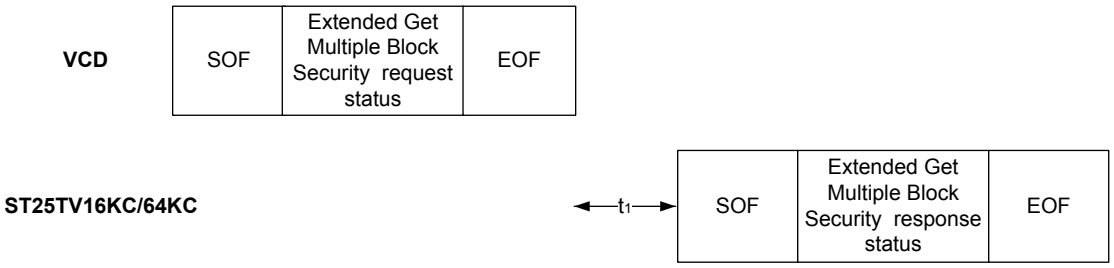
Table 137. Extended get multiple block security status response format when Error_flag is set

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 ST25TV16KC/64KC**



6.4.26 Read configuration

On receiving the read configuration command, the ST25TV16KC/64KC 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 138. 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 1 for details on register addresses.

Request parameters:

- System configuration register pointer
- UID (optional)

Table 139. 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

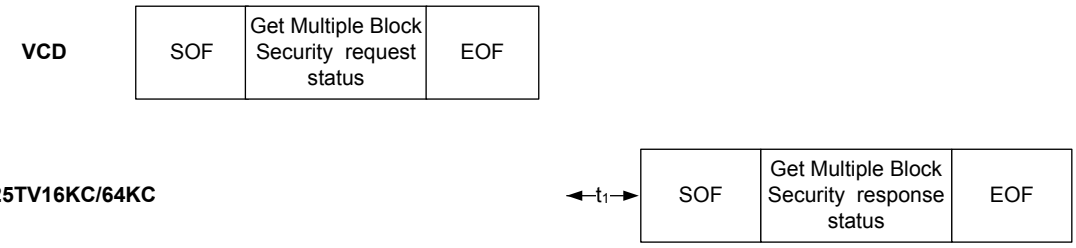
Table 140. Read configuration response format when Error_flag is set

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 ST25TV16KC/64KC



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 ST25TV16KC/64KC 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 ST25TV16KC/64KC 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 141. 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 142. 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 1 for details on register addresses.

Response parameter:

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

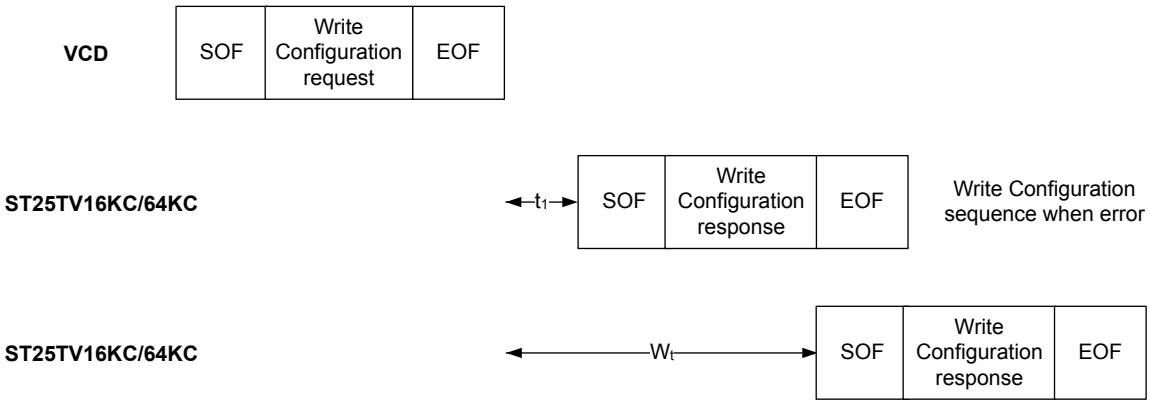
Table 143. Write configuration response format when Error_flag is set

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 ST25TV16KC/64KC**



6.4.28 Write password

On receiving the write password command, the ST25TV16KC/64KC 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 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 ST25TV16KC/64KC 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 ST25TV16KC/64KC 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 144. **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 145. **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.

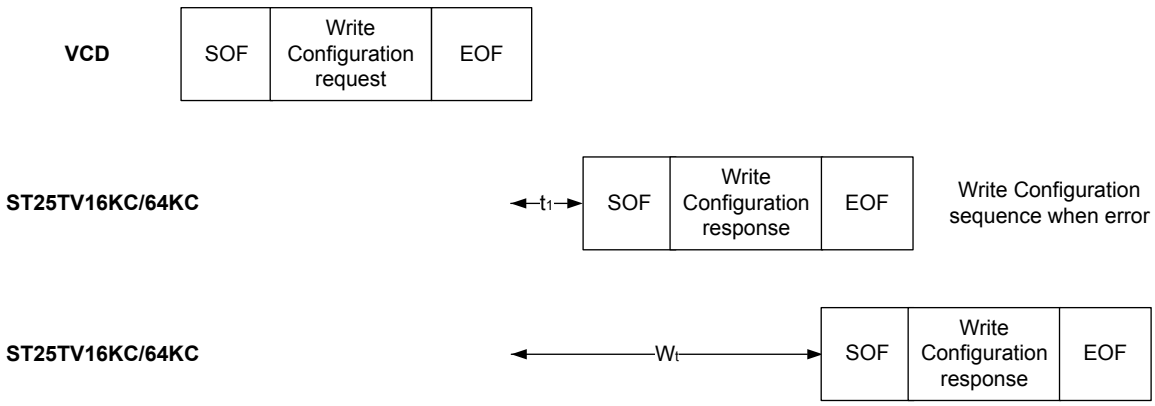
Table 146. Write password response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.29 Present password

On receiving the present password command, the ST25TV16KC/64KC compares the requested password with the data contained in the request and reports if the operation has been successful in the response. Refer to Data Protection for details on password management. After a successful command, the security session associated to the password is open as described in Data Protection.

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

Table 147. 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 148. **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.

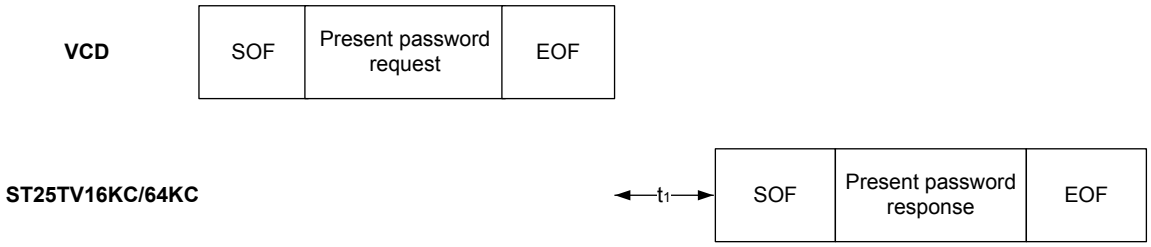
Table 149. **Present password response format when Error_flag is set**

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 ST25TV16KC/64KC**



6.4.30 Fast read single block

On receiving the fast read single block command, the ST25TV16KC/64KC 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 ST25TV16KC/64KC 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 ST25TV16KC/64KC can be addressed using this command.

Table 150. **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 151. 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 152)
- Four bytes of block data

Table 152. 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

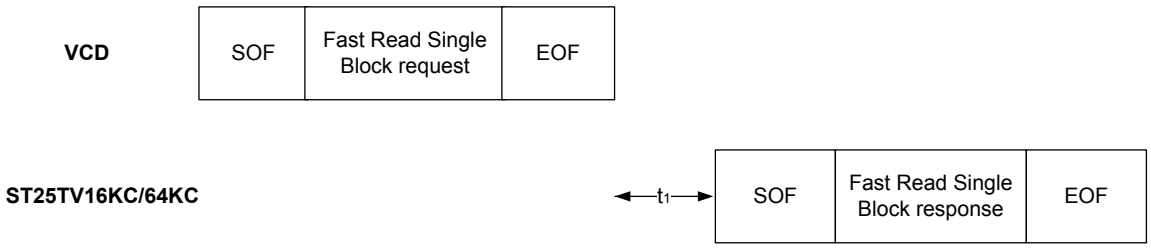
Table 153. Fast read single block response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.31 Fast extended read single block

On receiving the fast extended read single block command, the ST25TV16KC/64KC 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 ST25TV16KC/64KC 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 ST25TV16KC/64KC can be addressed using this command

Table 154. 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 155. 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 156)
- Four bytes of block data

Table 156. 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

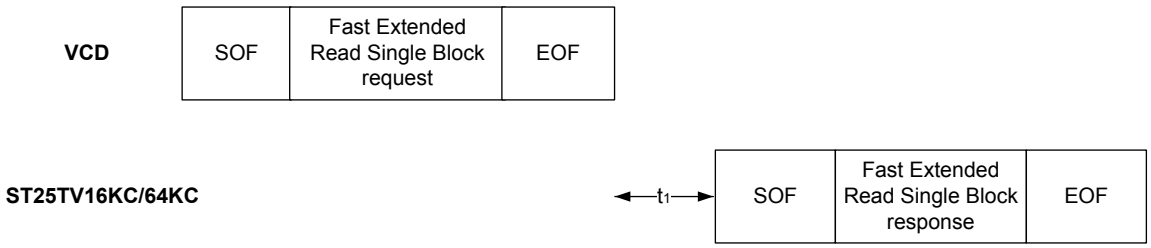
Table 157. Fast extended read single block response format when Error_flag is set

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 ST25TV16KC/64KC**



6.4.32 Fast read multiple blocks

On receiving the fast read multiple blocks command, the ST25TV16KC/64KC 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. Fast read multiple blocks command can cross areas borders, and returns all blocks until reaching a non readable block (block read protected or out of memory).

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 ST25TV16KC/64KC answers with an error code.

Block number is coded on 1 byte and only first 256 blocks of ST25TV16KC/64KC can be addressed using this command.

Table 158. **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 159. **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 160)
- N block of data

Table 160. 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

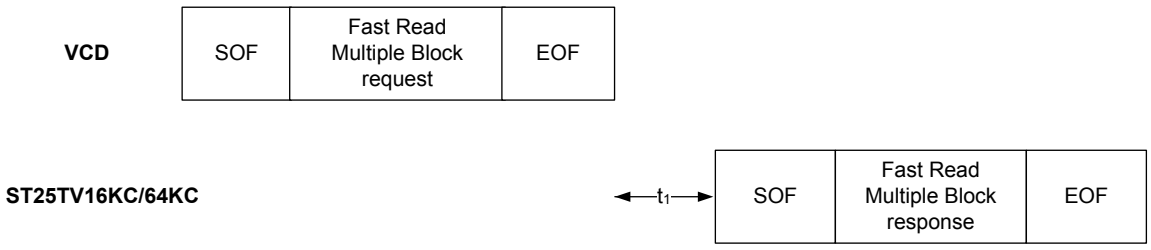
Table 161. Fast read multiple block response format when Error_flag is set

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 ST25TV16KC/64KC



6.4.33 Fast extended read multiple block

On receiving the fast extended read multiple block command, the ST25TV16KC/64KC 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. Fast Extended Read Multiple Blocks command can cross areas borders, and returns all blocks until reaching a non readable block (block read protected or out of memory).

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 ST25TV16KC/64KC 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 ST25TV16KC/64KC can be addressed using this command.

Table 162. 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 163. 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 164	16 bits	-

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

Response parameters:

- Block security status if Option_flag is set (see Table 164)
- N block of data

Table 164. 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

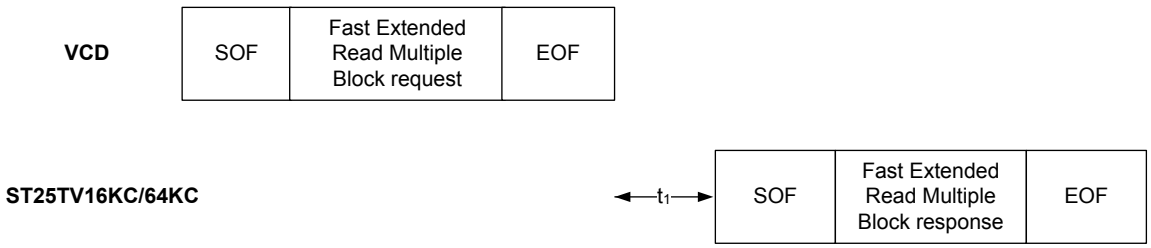
Table 165. Fast read multiple block response format when Error_flag is set

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 ST25TV16KC/64KC



7 Unique identifier (UID)

The devices are uniquely identified by a 64-bit unique identifier (UID), compliant with ISO/IEC 15963 and ISO/IEC 7816-6. The UID is a read-only code comprising:

- 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 166. UID format

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

1. *See Table 16 for ST product code value definition.*

With the UID, each ST25TV16KC/64KC device can be addressed uniquely and individually during the anticollision loop, and for one-to-one exchanges between a VCD and the device.

8 Device parameters

8.1 Maximum ratings

Stressing the device above the rating listed in Table 167 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.

Device mission profile (application conditions) is compliant with JEDEC JESD47 qualification standard. Extended mission profiles can be assessed on demand. Refer also to the STMicroelectronics SURE program and other relevant quality documents.

Table 167. 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_{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. *Evaluated by 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 following tables are derived from tests performed under the measurement conditions summarized in the relevant tables. Ensure that the circuit operating conditions match the measurement conditions when relying on the quoted parameters.

Table 168. 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(1)	T_A= -40 °C to 85 °C	150	-	5000	mA/m
$MI_{CARRIER}$	10% carrier modulation index MI = (A - B) / (A + B)(1)	150 mA/m > H_ISO > 1000 mA/m	10	-	30	%
	100% carrier modulation index(1)	MI = (A - B) / (A + B)	95	-	100	
t_{MINCD}	Minimum time from carrier generation to first data(1)	From H-field min	-	-	1	ms
f_{SH}	Subcarrier frequency high(1)	$f_{CC}/32$	-	423.75	-	kHz
f_{SL}	Subcarrier frequency low(1)	$f_{CC}/28$	-	484.28	-	
t_1	Time for device response(1)	$4352/f_{CC}$	318.6	320.9	323.3	µs
t_2	Time between commands(1)	$4192/f_{CC}$	309	311.5	314	
t_3	Time between commands(1)	$4384/f_{CC}$	323.3	-	-	
W_{t_Block}	RF user memory write time (including internal Verify)(1) (2)	1 block	-	5.2	-	ms
		4 blocks	-	19.7	-	
W_{t_Byte}	RF system memory write time (including internal Verify)(2)	1 byte	-	4.9	-	
C_{TUN}	Internal tuning capacitor (3)	f = 13.56 MHz	26.5	28.5	30.5	pF
V_{BACK}	Backscattered level as defined by ISO test(1)	-	10	-	-	mV
V_{MIN_1}	RF input voltage amplitude between AC0 and AC1, V_{AC0}-V_{AC1} peak to peak(1)	Inventory and Read operations	-	4.8	-	V
		Write operations	-	5.25	-	
t_{BootRF}	(1)	Set up time	-	0.6	-	ms
t_{RF_OFF}	RF OFF time(1)	Chip reset	2	-	-	

1. *Evaluated by characterization - not tested in production.*
2. *For VCD request coded in 1 out of 4 and device response in high data rate, single sub carrier.*
3. *Evaluated by characterization at 25°C– Tested in production at 25°C by correlating industrial tester measure with characterization results.*

Note: All timing characterization where performed on a reference antenna with the following characteristics: ISO antenna class 1 Tuning frequency = 13.7 MHz

Table 169. Operating conditions

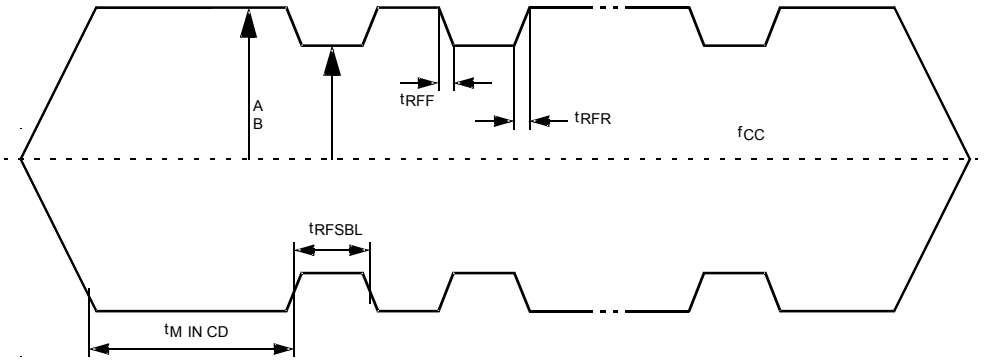
Symbol	Parameter	Min.	Max.	Unit
T_A	Ambient operating temperature	- 40	85	°C

Figure 37 shows an ASK modulated signal from the VCD to the ST25TV16KC/64KC device. The test conditions for the AC/DC parameters are:

- Close coupling condition with tester antenna (1 mm)
- Device performance measured at the tag antenna

- Device synchronous timing, transmit and receive

Figure 37. ASK modulated signal



9 Ordering information

Table 170. Ordering information scheme

Example:	ST25TV	64K	C	A	P	G	3
Device type							
ST25TV= Dynamic NFC/RFID tag based on ISO 15693 and NFC T5T							
Memory size							
16 K = 16 Kbits							
64 K = 64 Kbits							
Version							
C							
Interface							
A = None							
Device feature							
P = Password							
Package							
G = 120um +/- 15um 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.

Appendix A Bit representation and coding for fast commands

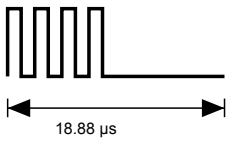
Data bits are encoded using Manchester coding, according to the following schemes. For the low data rate, same subcarrier frequency or frequencies is/are used. In this case, the number of pulses is multiplied by 4 and all times increase by this factor. For the fast commands using one subcarrier, all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

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_{CC} / 32) followed by an unmodulated time of 9.44 µs, as shown in Figure 38.

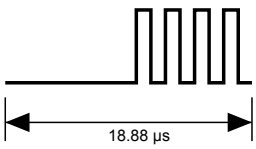
Figure 38. Logic 0, high data rate, fast commands



DT12066bV1

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_{CC} / 32), as shown in Figure 39 .

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

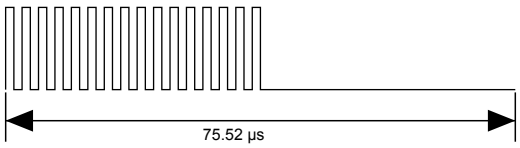


DT12067bV1

A.1.2 Low data rate

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

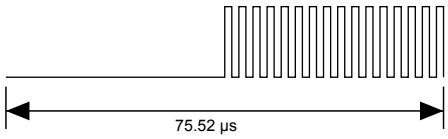
Figure 40. Logic 0, low data rate, fast commands



DT12069bV1

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_{CC} / 32), as shown in Figure 41.

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



DT12071bV1

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

A.2 VICC to VCD frames

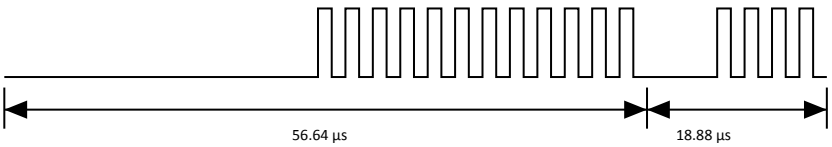
Frames are delimited by an SOF and an EOF. They are implemented using code violation. Unused options are reserved for future use. For the low data rate, the same subcarrier frequency or frequencies is/are used. In this case, the number of pulses is multiplied by 4. For the fast commands using one subcarrier,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

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_{CC} / 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.

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

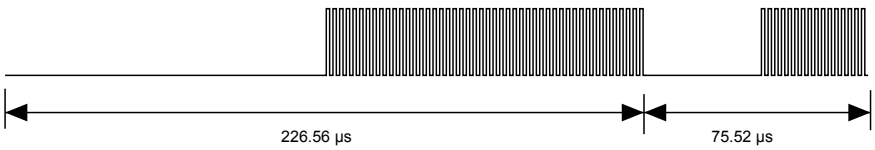


DT12079bV1

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_{CC} / 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**



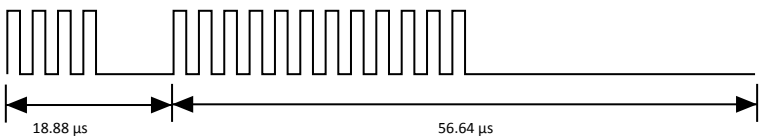
DT12081bV1

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_{CC} / 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



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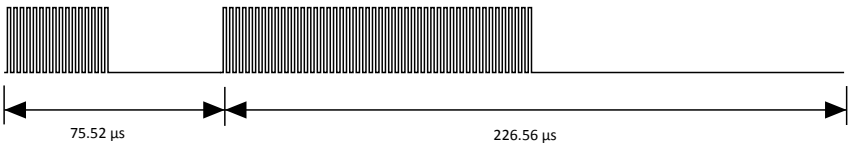
A.4.2 Low data rate

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_{CC} / 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



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

Revision history

Table 171. **Document revision history**

Date	Revision	Changes
14-Sep-2023	1	Initial release.

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