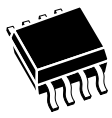
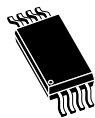


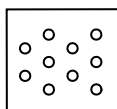
# Dynamic NFC/RFID tag IC with 4-Kbit, 16-Kbit or 64-Kbit EEPROM, fast transfer mode capability and optimized I<sup>2</sup>C



SO8



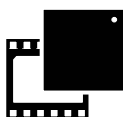
TSSOP8



WLCSP10



UFDFPN8



UFDFPN12


**Product status link**
[ST25DV04KC](#)
[ST25DV16KC](#)
[ST25DV64KC](#)

## Features

### I<sup>2</sup>C interface

- Two-wire I<sup>2</sup>C serial interface supports 1MHz protocol
- Single supply voltage: 1.8 V to 5.5 V
- Multiple byte write programming (up to 256 bytes)
- Configurable I<sup>2</sup>C slave address

### 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 blocks read (same for Extended commands)
- Single and multiple blocks write (up to four) (same for Extended commands)
- Internal tuning capacitance: 28.5 pF

### Memory

- Up to 64 Kbit of EEPROM (depending on version)
- I<sup>2</sup>C interface accesses bytes
- RF interface accesses blocks of 4 bytes
- Write time:
  - From I<sup>2</sup>C: typical 5 ms for 1 up to 16 bytes
  - From RF: typical 5 ms for one block
- Data retention: 40 years
- Write cycles endurance:
  - 1 million write cycles at 25 °C
  - 600k write cycles at 85 °C
  - 500k write cycles at 105 °C
  - 400k write cycles at 125 °C

### Fast transfer mode

- Fast data transfer between I<sup>2</sup>C and RF interfaces
- Half-duplex 256 bytes dedicated buffer

### Energy harvesting

- Analog output pin to power external components

### Data protection

- User memory: one to four configurable areas, protectable in read and/or write by three 64-bit passwords in RF and one 64-bit password in I<sup>2</sup>C
- System configuration: protected in write by a 64-bit password in RF and a 64-bit password in I<sup>2</sup>C

**GPO**

- Interruption pin configurable on multiple RF events (field change, memory write, activity, fast transfer end, user set/reset/pulse), and I<sup>2</sup>C events (memory write completed, RF switch off)
- Open drain or CMOS output (depending on version)

**Low power mode (10-ball and 12-pin package only)**

- Input pin to trigger low power mode

**RF management**

- RF command interpreter enabled/disabled from I<sup>2</sup>C host controller
- I<sup>2</sup>C priority: immediate RF switch off from I<sup>2</sup>C

**Temperature range**

- Range 6:
  - From -40 °C to 85 °C
- Range 8:
  - From -40 °C to 85 °C (UDFPN8 and UDFPN12 only)
  - From -40 °C to 125 °C (SO8N and TSSOP8 only, 105 °C max on RF interface)

**Package**

- 8-pin, 10-ball, and 12-pin packages
- ECOPACK2 (RoHS compliant)

# 1 Description

The **ST25DV04KC**, **ST25DV16KC** and **ST25DV64KC** devices are NFC RFID tags offering respectively 4-Kbit, 16-Kbit, and 64-Kbit of electrically erasable programmable memory (EEPROM). The **ST25DV04KC**, **ST25DV16KC** and **ST25DV64KC** offer two interfaces. The first one is an I<sup>2</sup>C serial link and can be operated from a DC power supply. The second one is an RF link activated when the **ST25DV04KC**, **ST25DV16KC** and **ST25DV64KC** act as a contactless memory powered by the received carrier electromagnetic wave.

In I<sup>2</sup>C mode, the **ST25DV04KC**, **ST25DV16KC** and **ST25DV64KC** user memories contain up to 512 bytes, 2048 bytes and 8192 bytes, which could be split in 4 flexible and protectable areas.

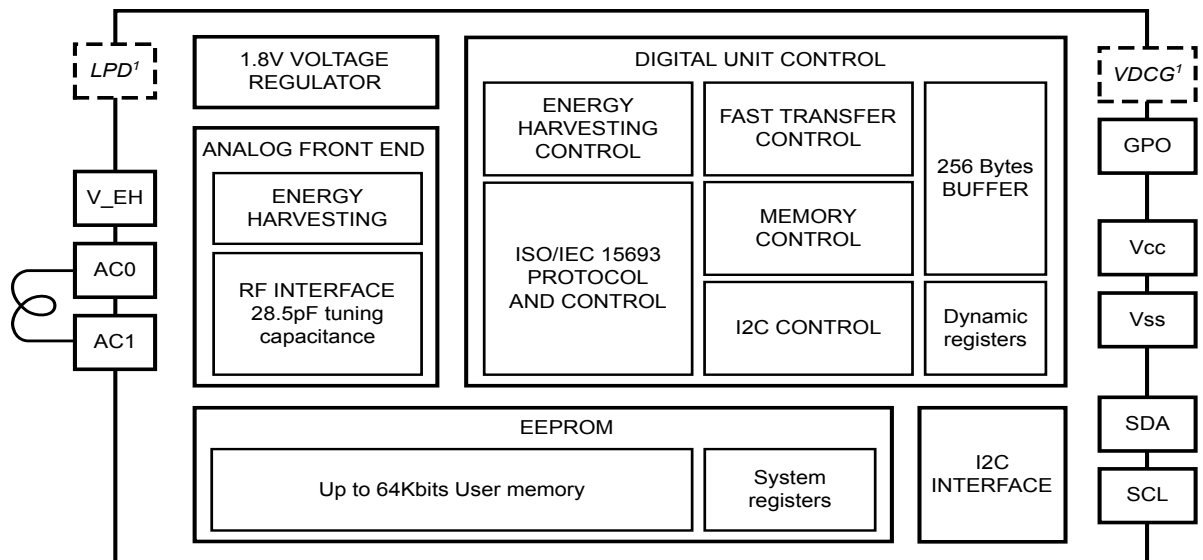
In RF mode, following ISO/IEC 15693 or NFC forum type 5 recommendations, the **ST25DV04KC**, **ST25DV16KC** and **ST25DV64KC** user memory contains respectively up to 128 blocks, 512 blocks and 2048 blocks of 4 bytes which could be split in 4 flexible and protectable areas.

The **ST25DV04KC**, **ST25DV16KC** and **ST25DV64KC** offer a fast transfer mode between the RF and contact worlds, thanks to a 256 byte volatile buffer (also called Mailbox). In addition, the GPO pin of the **ST25DV04KC**, **ST25DV16KC** and **ST25DV64KC** provides data informing the contact world about incoming events, like RF field detection, RF activity in progress or mailbox message availability. An energy harvesting feature is also proposed when external conditions make it possible.

Herein after all concerned devices (**ST25DV04KC**, **ST25DV16KC** and **ST25DV64KC**) are mentioned as **ST25DVxxKC**.

## 1.1 ST25DVxxKC block diagram

Figure 1. ST25DVxxKC block diagram



1. V<sub>DCG</sub> and LPD are included in the 10-ball and 12-pin package only.

## 1.2 ST25DVxxKC packaging

ST25DVxxKC is provided in 8-pin, 10-ball, and 12-pin packages:

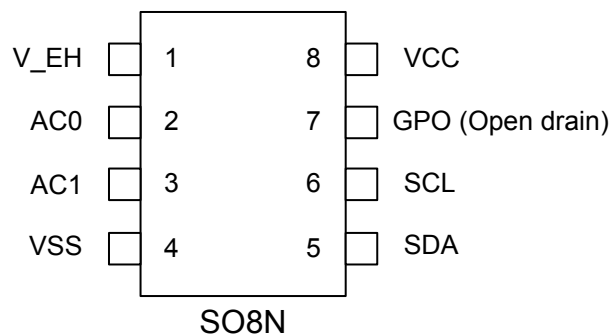
- SO8N, TSSOP8, or UDFPN8 8-pin packages for the open drain version of interrupt output
- 10 balls (WLCSP) and 12 pins (UDFPN12) for the CMOS version of interrupt output. These packages include an additional element that minimizes the standby consumption

**Table 1. 8-pin packages signal names**

Signal name	Function	Direction
V_EH	Energy harvesting	Power output
GPO	Interrupt output	Output
SDA	Serial data	I/O
SCL	Serial clock	Input
AC0, AC1	Antenna coils	-
V <sub>CC</sub>	Supply voltage	Power
V <sub>SS</sub>	Ground	-
EP <sup>(1)</sup>	Exposed pad	Must be left floating

1. Available only on UDFPN8 packages.

**Figure 2. ST25DVxxKC 8-pin SO8N package connections**



**Figure 3. ST25DVxxKC 8-pin TSSOP8 package connections**

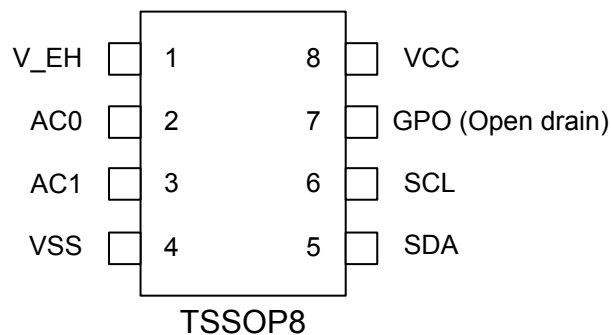


Figure 4. ST25DVxxKC 8-pin UDFN8 package connections

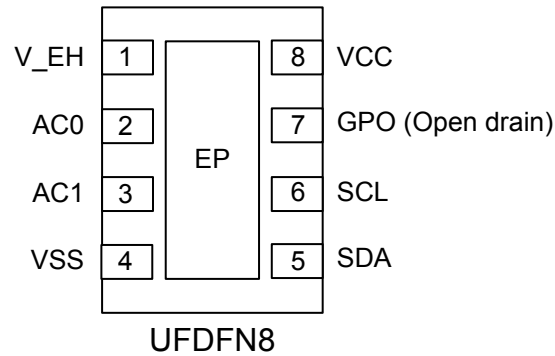
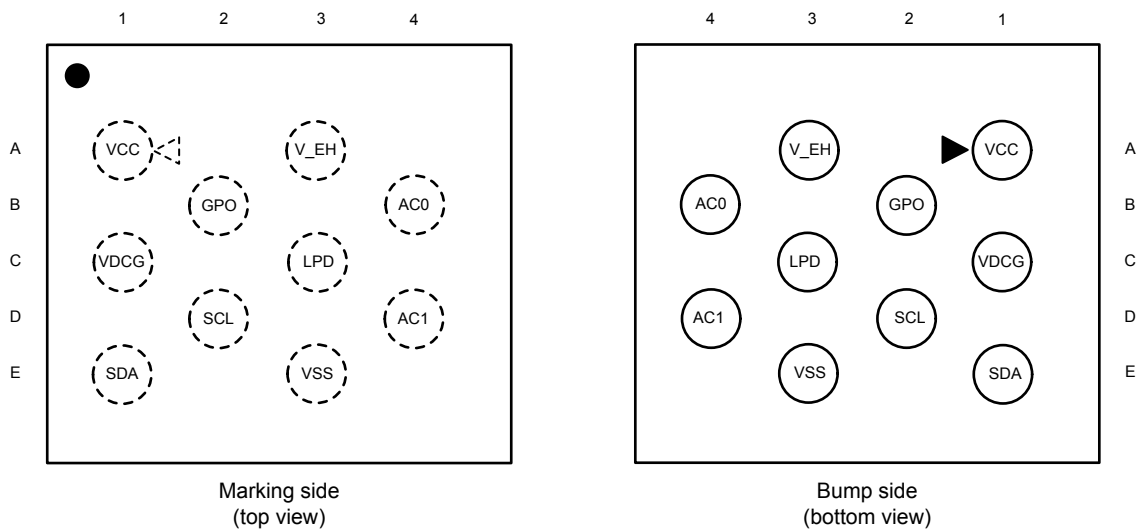


Table 2. 10-pin packages signal names

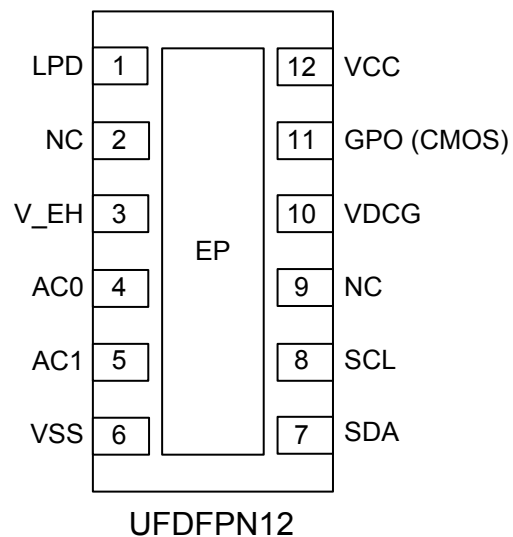
Signal name	Function	Direction
V_EH	Energy harvesting	Power output
GPO	Interrupt output	Output
SDA	Serial data	I/O
SCL	Serial clock	Input
AC0, AC1	Antenna coils	-
V <sub>CC</sub>	Supply voltage	Power
V <sub>SS</sub>	Ground	-
LPD	Low power down mode	Input
V <sub>DCCG</sub>	Supply voltage for GPO driver	Power

Figure 5. 10-ball WLCSP package connections



**Table 3. 12-pin packages signal names**

Signal name	Function	Direction
V_EH	Energy harvesting	Power output
GPO	Interrupt output	Output
SDA	Serial data	I/O
SCL	Serial clock	Input
AC0, AC1	Antenna coils	-
V <sub>CC</sub>	Supply voltage	Power
V <sub>SS</sub>	Ground	-
LPD	Low power down mode	Input
V <sub>DCG</sub>	Supply voltage for GPO driver	Power
NC	Not connected	Must be left floating
EP	Exposed pad	Must be left floating

**Figure 6. ST25DVxxKC 12-pin UDFPN12 package connections**


## 2 Signal descriptions

### 2.1 Serial link (SCL, SDA)

#### 2.1.1 Serial clock (SCL)

This input signal is used to strobe all data in and out of the ST25DVxxKC. In applications where this signal is used by slave devices to synchronize the bus to a slower clock, the bus master must have an open drain output, and a pull-up resistor must be connected from serial clock (SCL) to  $V_{CC}$ . See [Section 9.2 I2C DC and AC parameters](#) to know how to calculate the value of this pull-up resistor.

#### 2.1.2 Serial data (SDA)

This bidirectional signal is used to transfer data in or out of the ST25DVxxKC. It is an open drain output that may be wire-OR'ed with other open drain or open collector signals on the bus. A pull-up resistor must be connected from serial data (SDA) to  $V_{CC}$ . ([Figure 82. I<sup>2</sup>C Fast mode \( \$f\_C = 1\$  MHz\): maximum  \$R\_{bus}\$  value versus bus parasitic capacitance \( \$C\_{bus}\$ \)](#) indicates how the value of the pull-up resistor can be calculated).

### 2.2 Power control ( $V_{CC}$ , LPD, $V_{SS}$ )

#### 2.2.1 Supply voltage ( $V_{CC}$ )

This pin can be connected to an external DC supply voltage.

*Note:* *An internal voltage regulator allows the external voltage applied on  $V_{CC}$  to supply the ST25DVxxKC, while preventing the internal power supply (rectified RF waveforms) to output a DC voltage on the  $V_{CC}$  pin.*

#### 2.2.2 Low power down (LPD)

This input signal is used to control an internal 1.8 V regulator delivering the ST25DVxxKC internal supply. When LPD is high, this regulator is shut off and its consumption is reduced below 1  $\mu$ A.

This regulator has a turn on time in the range of 100  $\mu$ s to be added to the boot duration, before the device becomes fully operational. The impedance on LDP pin when set high should not exceed 5 k $\Omega$ . The LPD pin is internally pulled down.

This feature is only available on the 10-ball and 12-pin ST25DVxxKC packages.

#### 2.2.3 Ground ( $V_{SS}$ )

$V_{SS}$  is the reference for the  $V_{CC}$  and  $V_{DCG}$  supply voltages and  $V_{EH}$  analogic output voltage.

## 2.3 RF link (AC0 AC1)

### 2.3.1 Antenna coil (AC0, AC1)

These inputs are used to connect the ST25DVxxKC device to an external coil exclusively. It is advised not to connect any other DC or AC path to AC0 or AC1.

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

## 2.4 Process control (GPO, V<sub>DCG</sub>)

### 2.4.1 Driver supply voltage (V<sub>DCG</sub>)

This pin, available only with 10-ball and 12-pin ST25DVxxKC packages, can be connected to an external DC supply voltage. It only supplies the GPO (CMOS) driver block.

ST25DVxxKC cannot be powered by V<sub>DCG</sub>. If V<sub>DCG</sub> is left floating, there is not any information available on the GPO (CMOS) pin.

### 2.4.2 General purpose output (GPO)

The ST25DVxxKC features a configurable output GPO pin used to provide RF and I<sup>2</sup>C activity information to an external device.

Depending on the ST25DVxxKC package version, there are two types of GPO output:

- 8-pin ST25DVxxKC packages offer an open drain GPO output. This GPO pin must be connected to an external pull-up resistor (> 4.7 kΩ) to operate.
- 10-ball and 12-pin ST25DVxxKC packages offer a CMOS GPO output, which requires to connect V<sub>DCG</sub> pin to an external power supply. The interrupt consists of setting the state to a high level, or outputting a positive pulse on the GPO pin.

GPO pin is a configurable output signal, and can mix several interruption modes. By default, the GPO register sets the interruption mode as an RF field change detector. It is able to raise various events like RF activity, Memory write completion, or fast transfer actions. It can authorize the RF side to directly drive the GPO pin using the Manage GPO command, to set the output state, or emit a single pulse (for example, to wake up an application.). See [Section 5.4 GPO](#) for details.

## 2.5 Energy harvesting analog output (V<sub>EH</sub>)

This analog output pin is used to deliver the analog voltage V<sub>EH</sub> available when the Energy harvesting mode is enabled and if the RF field strength is sufficient. When the Energy harvesting mode is disabled or the RF field strength is not sufficient, V<sub>EH</sub> pin is in High-Z state (See [Section 5.5 Energy harvesting \(EH\)](#) for details).

Energy harvesting voltage output is not regulated.



### 3 Power management

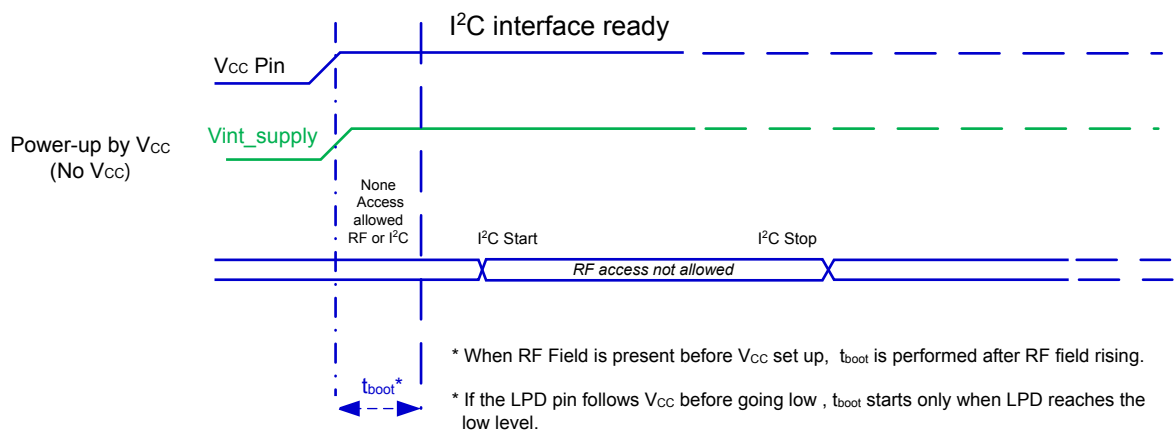
#### 3.1 Wired interface

##### Operating supply voltage $V_{CC}$

In contact mode, prior to selecting the memory and issuing instructions to it, a valid and stable  $V_{CC}$  voltage within the specified [ $V_{CC(min)}$ ,  $V_{CC(max)}$ ] range must be applied (see Table 246. [I<sup>2</sup>C operating conditions](#)). To maintain a stable DC supply voltage, it is recommended to decouple the  $V_{CC}$  line with a suitable capacitor (usually of the order of 10 nF and 100 nF) close to the  $V_{CC}/V_{SS}$  package pins.

This voltage must remain stable and valid until the end of the transmission of the instruction and, for a Write instruction, until the completion of the internal I<sup>2</sup>C write cycle ( $t_W$ ). Instructions are not taken into account until completion of ST25DVxxKC's boot sequence (see the figure below).

**Figure 7. ST25DVxxKC power-up sequence (No RF field, LPD pin tied to  $V_{SS}$  or package without LPD pin)**



##### Power-up conditions

When the power supply is turned on,  $V_{CC}$  rises from  $V_{SS}$  to  $V_{CC}$ . The  $V_{CC}$  rise time must not vary faster than 1 V/ $\mu$ s.

##### Device reset in I<sup>2</sup>C mode

In order to prevent inadvertent write operations during power-up, a power-on reset (POR) circuit is included. At power-up (continuous rise of  $V_{CC}$ ), the ST25DVxxKC does not respond to any I<sup>2</sup>C instruction until  $V_{CC}$  has reached the power-on reset threshold voltage (this threshold is lower than the minimum  $V_{CC}$  operating voltage defined in Table 246. [I<sup>2</sup>C operating conditions](#)). When  $V_{CC}$  passes over the POR threshold, the device is reset and enters the Standby power mode. However, the device must not be accessed until  $V_{CC}$  has reached a valid and stable  $V_{CC}$  voltage within the specified [ $V_{CC(min)}$ ,  $V_{CC(max)}$ ] range and  $t_{boot}$  time necessary to ST25DVxxKC set-up has passed.

In the version supporting LPD pin, the  $t_{boot}$  takes place only when LPD goes low.

In a similar way, during power-down (continuous decrease in  $V_{CC}$ ), as soon as  $V_{CC}$  drops below the power-on reset threshold voltage, the device stops responding to any instruction sent to it, and I<sup>2</sup>C address counter is reset.

##### Power-down mode

During power-down (continuous decay of  $V_{CC}$ ), the device must be in Standby power mode (mode reached after decoding a Stop condition, assuming that there is no internal write cycle in progress).

### 3.2 Contactless interface

#### Device set in RF mode

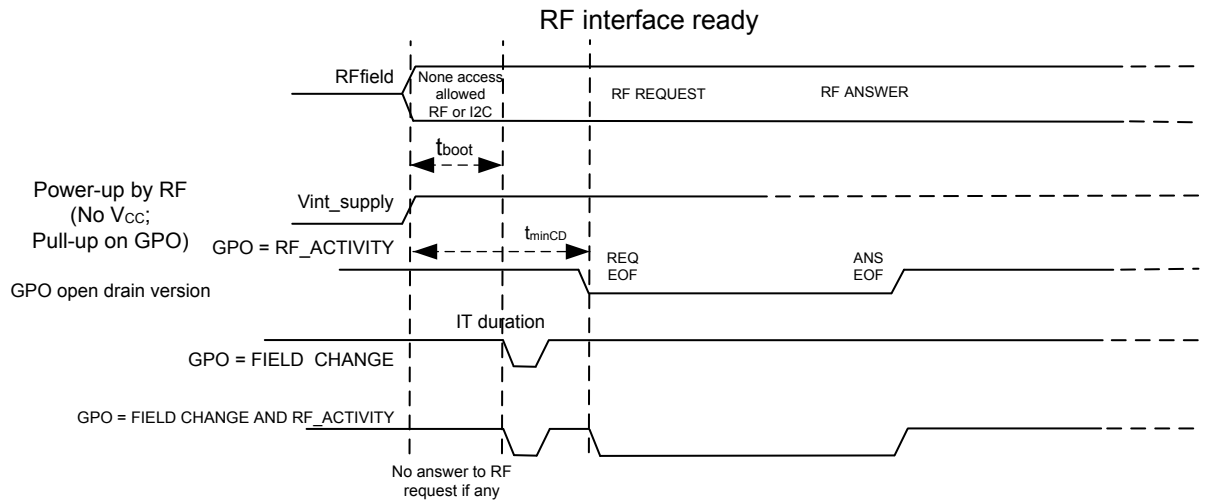
To ensure a proper boot of the RF circuitry, the RF field must be turned ON without any modulation for a minimum period of time  $t_{RF\_ON}$ . Before this time, ST25DVxxKC ignores all received RF commands. (See Figure 8. ST25DVxxKC RF power-up sequence (No DC supply)).

#### Device reset in RF mode

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

The RF access can be temporarily or indefinitely disabled by setting the appropriate value in the RF disable register.

**Figure 8. ST25DVxxKC RF power-up sequence (No DC supply)**



## 4 Memory management

### 4.1 Memory organization overview

The ST25DVxxKC memory is divided in four main memory areas:

- User memory
- Dynamic registers
- Fast transfer mode buffer
- System configuration area

The ST25DVxxKC user memory can be divided into 4 flexible user areas. Each area can be individually read - and/or - write-protected with one out of three specific 64-bit password.

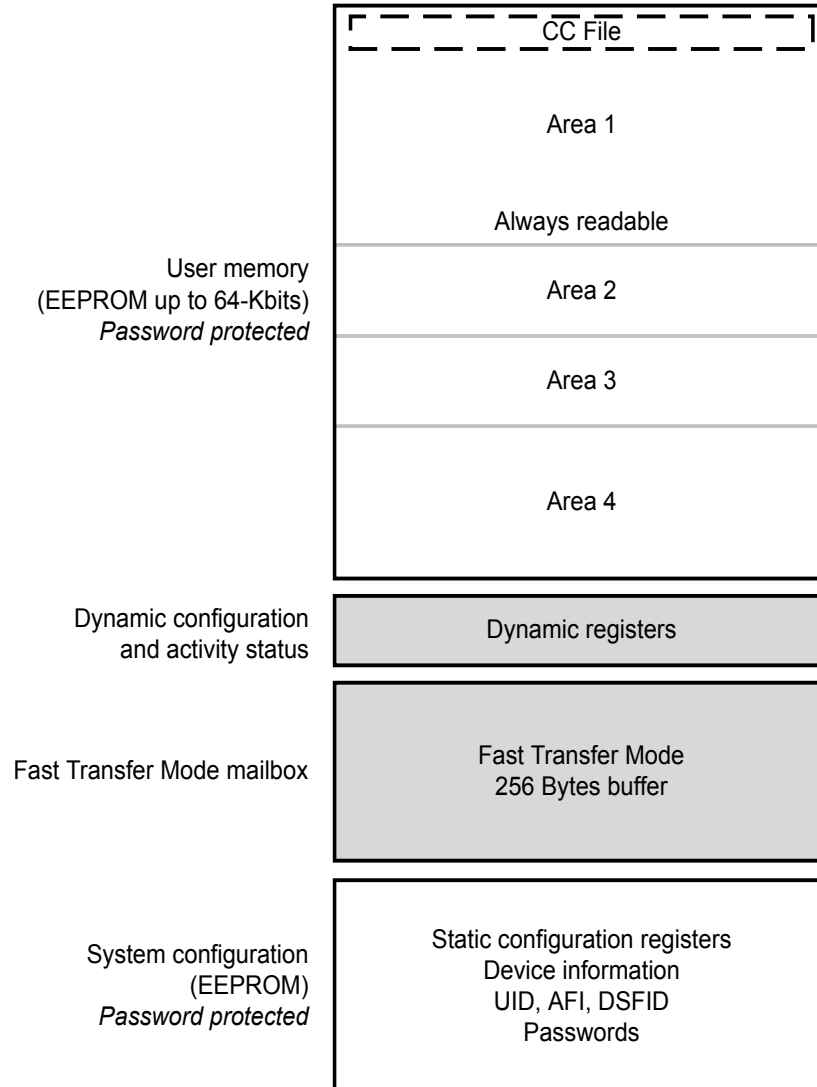
The ST25DVxxKC dynamic registers are accessible by RF or I<sup>2</sup>C host and provide dynamic activity status or allow temporary activation or deactivation of some ST25DVxxKC features.

The ST25DVxxKC also provides a 256-byte fast transfer mode buffer, acting as a mailbox between RF and I<sup>2</sup>C interface, allowing fast data transfer between contact and contactless worlds.

Finally, the ST25DVxxKC system configuration area contains static registers to configure all ST25DVxxKC features, which can be tuned by the user. Its access is protected by a 64-bit configuration password.

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

The system configuration area includes five additional 64-bit blocks that store an I<sup>2</sup>C password plus three RF user area access passwords and an RF configuration password.

**Figure 9. Memory organization**


## 4.2 User memory

User memory is accessible from both RF contactless interface and I<sup>2</sup>C wired interface.

From RF interface, 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 ST25DVxxKC memory blocks. Other read and write commands can only address up to block FFh.

From I<sup>2</sup>C interface, user memory is addressed as Bytes, starting at address 0. Device select must set E2 = 0. User memory can be read in continuity. Unlike the RF interface, there is no roll-over when the requested address reaches the end of the memory capacity.

Table 4. User memory as seen by RF and by I<sup>2</sup>C shows how memory is seen from RF interface and from I<sup>2</sup>C interface.

**Table 4. User memory as seen by RF and by I<sup>2</sup>C**

RF command (block addressing)	User memory				I <sup>2</sup> C command (byte addressing)	
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				I <sup>2</sup> C Read command I <sup>2</sup> C Write command Device select E2 = 0	
	I <sup>2</sup> C byte 0003h	I <sup>2</sup> C byte 0002h	I <sup>2</sup> C byte 0001h	I <sup>2</sup> C byte 0000h		
	RF block (00)01h					
	I <sup>2</sup> C byte 0007h	I <sup>2</sup> C byte 0006h	I <sup>2</sup> C byte 0005h	I <sup>2</sup> C byte 0004h		
	RF block (00)02h					
	I <sup>2</sup> C byte 000Bh	I <sup>2</sup> C byte 000Ah	I <sup>2</sup> C byte 0009h	I <sup>2</sup> C byte 0008h		
	....					
	RF block (00)7Fh <sup>(1)</sup>					
	I <sup>2</sup> C byte 01FFh	I <sup>2</sup> C byte 01FEh	I <sup>2</sup> C byte 01FDh	I <sup>2</sup> C byte 01FCh		
	....					
	RF block (00)FFh <sup>(2)</sup>					
	I <sup>2</sup> C byte 03FFh	I <sup>2</sup> C byte 03FEh	I <sup>2</sup> C byte 03FDh	I <sup>2</sup> C 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				
		I <sup>2</sup> C byte 0403h	I <sup>2</sup> C byte 0402h	I <sup>2</sup> C byte 0401h		I <sup>2</sup> C byte 0400h
....						
RF block 01FFh <sup>(3)</sup>						
I <sup>2</sup> C byte 07FFh		I <sup>2</sup> C byte 07FEh	I <sup>2</sup> C byte 07FDh	I <sup>2</sup> C byte 07FCh		
....						
RF block 07FFh <sup>(4)</sup>						
I <sup>2</sup> C byte 1FFFh	I <sup>2</sup> C byte 1FFEh	I <sup>2</sup> C byte 1FFDh	I <sup>2</sup> C byte 1FFCh			

1. Last block of user memory in ST25DV04KC.
2. 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.
3. Last block of user memory in ST25DV04KC.
4. Last block of user memory in ST25DV64KC.

**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 and I<sup>2</sup>C write commands are legal only within a same area:

- In RF, Write Multiple Blocks and Extended Write Multiple Blocks command are not executed and return the error 0Fh if addresses cross an area border.
- In I<sup>2</sup>C, a sequential write is not executed and all bytes with addresses crossing the area border are not acknowledged if addresses cross an area border.

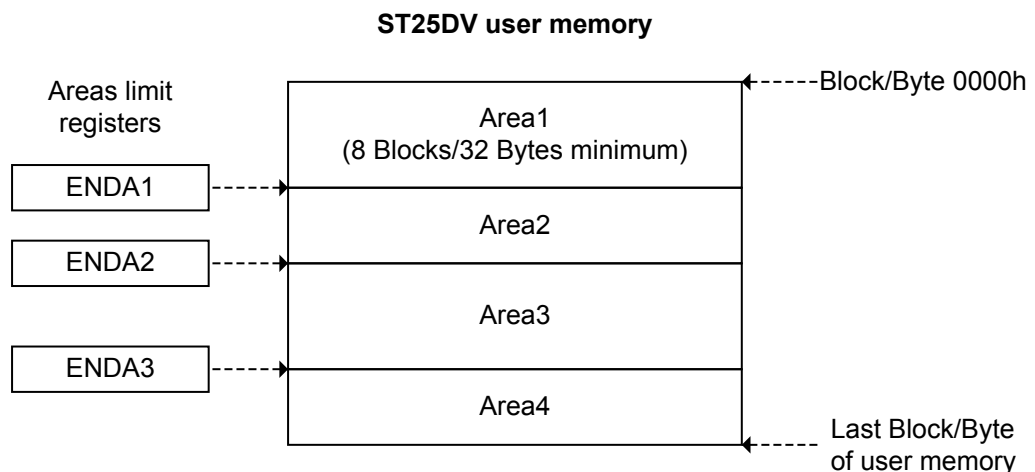
RF and I<sup>2</sup>C read commands are allowed over multiple areas:

- In RF, 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.
- In I<sup>2</sup>C, sequential read returns all readable bytes until reaching a non readable byte (address read protected or non available) even if addresses cross area borders. Non readable bytes return value FFh.

Each user memory area is defined by its ending address ENDA<sub>i</sub>. The starting address is implicitly defined by the end of the preceding area.

There are three ENDA<sub>i</sub> registers in the configuration system memory, used to define the end addresses of Area 1, Area 2 and Area 3. The end of Area 4 is always the last block/byte of memory and is not configurable.

**Figure 10. ST25DVxxKC user memory areas**



On factory delivery all ENDA<sub>i</sub> are set to maximum value, only Area1 exists and includes the full user memory.

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

An area's end limit is coded as followed in ENDA<sub>i</sub> registers:

- Last RF block address of area =  $8 \times \text{ENDA}_i + 7 \Rightarrow \text{ENDA}_i = \text{int}(\text{Last Area}_i \text{ RF block address} / 8)$
- Last I<sup>2</sup>C byte address of area =  $32 \times \text{ENDA}_i + 31 \Rightarrow \text{ENDA}_i = \text{int}(\text{Last Area}_i \text{ I}^2\text{C byte address} / 32)$
- As a consequence, ENDA1 = 0 minimum size of Area 1 is 8 blocks (32 bytes).

**Table 5. Maximum user memory block and byte addresses and ENDA<sub>i</sub> value**

Device	Last user memory block address seen by RF	Last user memory byte address seen by I <sup>2</sup> C	Maximum ENDA <sub>i</sub> value
ST25DV04KC	007Fh	01FFh	0Fh
ST25DV16KC	01FFh	07FFh	3Fh
ST25DV64KC	07FFh	1FFFh	FFh

**Table 6. Areas and limit calculation from ENDA<sub>i</sub> registers**

Area	Seen from RF interface	Seen from I <sup>2</sup> C interface
Area 1	Block 0000h	Byte 0000h
	...	...
	Block (END A1*8)+7	Byte (END A1*32)+31
Area 2	Block (END A1+1)*8	Byte (END A1+1)*32
	...	...
	Block (END A2*8)+7	Byte (END A2*32)+31
Area 3	Block (END A2+1)*8	Byte (END A2+1)*32
	...	...
	Block (END A3*8)+7	Byte (END A3*32)+31
Area 4	Block (END A3+1)*8	Byte (END A3+1)*32
	...	...
	Last memory Block	Last memory Byte

Organization of user memory in areas have the following characteristics:

- At least one area exists (Area1), starting at Block/Byte address 0000h and finishing at ENDA1, with ENDA1 = ENDA2 = ENDA3 = End of user memory (factory setting).
- Two Areas could be defined by setting ENDA1 < ENDA2 = ENDA3 = End of user memory.
- Three Areas may be defined by setting ENDA1 < ENDA2 < ENDA3 = End of user memory.
- A maximum of four areas may be defined by setting ENDA1 < ENDA2 < ENDA3 < End of user memory.
- Area 1 specificities
  - Start of Area1 is always Block/Byte address 0000h.
  - Area1 minimum size is 8 blocks (32 bytes) when ENDA1 = 00h.
  - Area1 is always readable.
- The last area always finishes on the last user memory Block/Byte address (END A4 doesn't exist).
- All areas are contiguous: end of Area(n) + one Block/Byte address is always start of Area(n+1).

#### Area size programming

RF user must first open the RF configuration security session to write ENDA<sub>i</sub> registers.

I<sup>2</sup>C host must first open I<sup>2</sup>C security session to write ENDA<sub>i</sub> registers.

When programming an ENDA<sub>i</sub> register, the following rule must be respected:

- ENDA<sub>i</sub>-1 < ENDA<sub>i</sub> ≤ ENDA<sub>i</sub>+1 = End of memory.

This means that prior to programming any ENDA<sub>i</sub> register, its successor (END A<sub>i</sub>+1) must first be programmed to the last Block/Byte 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 in RF, NoAck is returned in I<sup>2</sup>C, and programming is not done.

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

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

Example of successive user memory area setting (for a ST25DV64KC):

1. Initial state, 2 Areas are defined:
  - a. ENDA1 = 10h (Last block of Area 1: (10h x 8) + 7 = 0087h)
  - b. ENDA2 = FFh (Last block of Area 2: (FFh x 8) + 7 = 07FFh)
  - c. ENDA3 = FFh (No Area 3)
    - Area 1 from Block 0000h to 0087h (136 Blocks)
    - Area 2 from Block 0088h to 07FFh (1912 Blocks)
    - There is no Area 3
    - There is no Area 4
2. Split of user memory in four areas:
  - a. ENDA3 is not updated as it is already set to end of memory
  - b. ENDA2 is not updated as it is already set to end of memory
  - c. Set ENDA1 = 3Fh (Last block of Area 1: (3Fh x 8) + 7 = 01FFh)
  - d. Set ENDA2 = 5Fh (Last block of Area 1: (5Fh x 8) + 7 = 02FFh)
  - e. Set ENDA3 = BFh (Last block of Area 1: (BFh x 8) + 7 = 05FFh)
    - Area1 from Block 0000h to 01FFh (512 Blocks)
    - Area2 from Block 0200h to 02FFh (256 Blocks)
    - Area3 from Block 0300h to 05FFh (768 Blocks)
    - Area4 from Block 0600h to 07FFh (512 Blocks).
3. Return to a split in two equal areas:
  - a. Set ENDA3 = FFh
  - b. Set ENDA2 = FFh
  - c. Set ENDA1 = 7Fh (Last block of Area 1: (7Fh x 8) + 7 = 03FFh)
    - Area1 from Block 0000h to 03FFh (1024 Blocks)
    - Area2 from Block 0400h to 07FFh (1024 Blocks)
    - There is no Area3
    - There is no Area 4

Programming ENDA3 to FFh in step 2.a would have resulted in into an error, since rule ENDA<sub>i</sub>-1 < ENDA<sub>i</sub> would not been respected (ENDAA2 = ENDA3 in that case).



**Registers for user memory area configuration**
**Table 7. ENDA1 access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @05h	R always, W if RF configuration security session is open and configuration not locked	E2=1, E1=1, 0005h	R always, W if I <sup>2</sup> C security session is open
Write Configuration (cmd code A1h) @05h			

**Table 8. ENDA1**

Bit	Name	Function	Factory Value
b7-b0	ENDA1	End Area 1 = 8*ENDA1+7 when expressed in blocks (RF) End Area 1 = 32*ENDA1+31 when expressed in bytes (I <sup>2</sup> C)	ST25DV04KC: 0Fh ST25DV16KC: 3Fh ST25DV64KC: FFh

Note: Refer to Table 13. System configuration memory map for ENDA1 register.

**Table 9. ENDA2 access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @07h	R always, W if RF configuration security session is open and configuration not locked	E2=1, E1=1, 0007h	R always, W if I <sup>2</sup> C security session is open
Write Configuration (cmd code A1h) @07h			

**Table 10. ENDA2**

Bit	Name	Function	Factory Value
b7-b0	ENDA2	End Area 2 = 8 x ENDA2 + 7 when expressed in blocks (RF) End Area 2 = 32*ENDA2 + 31 when expressed in bytes (I <sup>2</sup> C)	ST25DV04KC: 0Fh ST25DV16KC: 3Fh ST25DV64KC: FFh

Note: Refer to Table 13. System configuration memory map for ENDA2 register.

**Table 11. ENDA3 access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @09h	R always, W if RF configuration security session is open and configuration not locked	E2=1, E1=1, 0009h	R always, W if I <sup>2</sup> C security session is open
Write Configuration (cmd code A1h) @09h			

**Table 12. ENDA3**

Bit	Name	Function	Factory Value
b7-b0	ENDA3	End Area 3 = 8 x ENDA3 + 7 when expressed in blocks (RF) End Area 3 = 32 x ENDA3 + 31 when expressed in bytes (I <sup>2</sup> C)	ST25DV04KC: 0Fh ST25DV16KC: 3Fh ST25DV64KC: FFh

Note: Refer to Table 13. System configuration memory map for ENDA3 register.

### 4.3 System configuration area

In addition to EEPROM user memory, ST25DVxxKC includes a set of static registers located in the system configuration area memory (EEPROM nonvolatile registers). Those registers are set during device configuration (that is: area extension), or by the application (that is: area protection). Static registers content is read during the boot sequence and define basic ST25DVxxKC behaviour.

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

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

The system configuration area write access by RF can also be deactivated by I<sup>2</sup>C host.

In I<sup>2</sup>C static registers located in the system configuration area can be accessed with I<sup>2</sup>C read and write commands with device select E2=1, E1=1. Readable system areas could be read in continuity.

I<sup>2</sup>C security session must first be open, by presenting a valid I<sup>2</sup>C password, to grant write access to system configuration registers.

The following table shows the complete map of the system configuration area, as seen by RF and I<sup>2</sup>C interface.

**Table 13. System configuration memory map**

RF access		Static Register		I <sup>2</sup> C access		
Address	Type	Name	Function	Device select	Address	Type
00h	RW <sup>(1)</sup>	GPO1	Enable/disable GPO output and GPO ITs for RF events	E2=1, E1=1	0000h	RW <sup>(2)</sup>
01h	RW <sup>(1)</sup>	GPO2	Enable/disable GPO ITs for I <sup>2</sup> C events and set Interruption pulse duration	E2=1, E1=1	0001h	RW <sup>(2)</sup>
02h	RW <sup>(1)</sup>	EH_MODE	Energy Harvesting default strategy after Power ON	E2=1, E1=1	0002h	RW <sup>(2)</sup>
03h	RW <sup>(1)</sup>	RF_MNGT	RF interface state after Power ON	E2=1, E1=1	0003h	RW <sup>(2)</sup>
04h	RW <sup>(1)</sup>	RFA1SS	Area1 RF access protection	E2=1, E1=1	0004h	RW <sup>(2)</sup>
05h	RW <sup>(1)</sup>	ENDA1	Area 1 ending point	E2=1, E1=1	0005h	RW <sup>(2)</sup>
06h	RW <sup>(1)</sup>	RFA2SS	Area2 RF access protection	E2=1, E1=1	0006h	RW <sup>(2)</sup>
07h	RW <sup>(1)</sup>	ENDA2	Area 2 ending point	E2=1, E1=1	0007h	RW <sup>(2)</sup>
08h	RW <sup>(1)</sup>	RFA3SS	Area3 RF access protection	E2=1, E1=1	0008h	RW <sup>(2)</sup>
09h	RW <sup>(1)</sup>	ENDA3	Area 3 ending point	E2=1, E1=1	0009h	RW <sup>(2)</sup>
0Ah	RW <sup>(1)</sup>	RFA4SS	Area4 RF access protection	E2=1, E1=1	000Ah	RW <sup>(2)</sup>
No access		I2CSS	Area 1 to 4 I <sup>2</sup> C access protection	E2=1, E1=1	000Bh	RW <sup>(2)</sup>
N/A	RW <sup>(3) (4)</sup>	LOCK_CCFILE	Blocks 0 and 1 RF Write protection	E2=1, E1=1	000Ch	RW <sup>(2)</sup>
0Dh	RW <sup>(1)</sup>	FTM	Fast transfer mode authorization and watchdog setting.	E2=1, E1=1	000Dh	RW <sup>(2)</sup>
No access		I2C_CFG	I <sup>2</sup> C slave address configuration and enable/disable RF switch off from I <sup>2</sup> C.	E2=1, E1=1	000Eh	RW <sup>(2)</sup>

RF access		Static Register		I <sup>2</sup> C access		
Address	Type	Name	Function	Device select	Address	Type
0Fh	RW <sup>(1)</sup>	LOCK_CFG	Protect RF Write to system configuration registers	E2=1, E1=1	000Fh	RW <sup>(2)</sup>
N/A	WO <sup>(5)</sup>	LOCK_DSFD	DSFID lock status	E2=1, E1=1	0010h	RO
NA	WO <sup>(6)</sup>	LOCK_AFI	AFI lock status	E2=1, E1=1	0011h	RO
N/A	RW <sup>(5)</sup>	DSFID	DSFID value	E2=1, E1=1	0012h	RO
N/A	RW <sup>(6)</sup>	AFI	AFI value	E2=1, E1=1	0013h	RO
N/A	RO	MEM_SIZE	Memory size value in blocks, 2 bytes	E2=1, E1=1	0014h to 0015h	RO
	RO	BLK_SIZE	Block size value in bytes	E2=1, E1=1	0016h	RO
N/A	RO	IC_REF	IC reference value	E2=1, E1=1	0017h	RO
NA	RO	UID	Unique identifier, 8 bytes	E2=1, E1=1	0018h to 001Fh	RO
No access		IC_REV	IC revision	E2=1, E1=1	0020h	RO
		-	ST Reserved	E2=1, E1=1	0021h	RO
		-	ST Reserved	E2=1, E1=1	0022h	RO
		-	ST Reserved	E2=1, E1=1	0023h	RO
			I <sup>2</sup> C_PWD	I <sup>2</sup> C security session password, 8 bytes	E2=1, E1=1	0900h to 0907h
N/A	WO <sup>(9)</sup>	RF_PWD_0	RF configuration security session password, 8 bytes	No access		
N/A	WO <sup>(9)</sup>	RF_PWD_1	RF user security session password 1, 8 bytes			
N/A	WO <sup>(9)</sup>	RF_PWD_2	RF user security session password 2, 8 bytes			
N/A	WO <sup>(9)</sup>	RF_PWD_3	RF user security session password 3, 8 bytes			

- Write access is granted if RF configuration security session is open and configuration is not locked (LOCK\_CFG register equals to 0).
- Write access if I<sup>2</sup>C security session is open.
- Write access to bit 0 if Block 00h is not already locked and to bit 1 if Block 01h is not already locked.
- LOCK\_CCFILE content is only readable through reading the Block Security Status of blocks 00h and 001h (see Section 5.6.3 User memory protection)
- Write access if DSFID is not locked
- Write access if AFI is not locked.
- Write access with I<sup>2</sup>C Write Password command, only after presenting a correct I<sup>2</sup>C password.
- Read access is granted if I<sup>2</sup>C security session is open.
- Write access only if corresponding RF security session is open.

## 4.4 Dynamic configuration

ST25DVxxKC has a set of dynamic registers that allow temporary modification of its behavior or report on its activity. Dynamic registers are volatile and not restored to their previous values after POR.

Some static registers have an image in dynamic registers: dynamic register value is initialized with the static register value and may be updated by the application to modify the device behavior temporarily (i.e.: set reset of Energy Harvesting). When a valid change occurs in a static register, in RF or I<sup>2</sup>C, the corresponding dynamic register is automatically updated.

Other, dynamic registers, automatically updated, contain indication on ST25DVxxKC activity. (for instance: IT\_STS\_Dyn gives the interruption's status or MB\_CTRL\_Dyn gives the fast transfer mode mailbox control).

In RF, dynamic registers can be accessed via dedicated (Fast) Read Dynamic Configuration and (Fast) Write Dynamic Configuration commands, with a pointer acting as the register address. No password is needed to access dynamic registers.

In I<sup>2</sup>C, dynamic registers can be accessed with I<sup>2</sup>C read and write commands with device select E2=0, E1=1. Dynamic registers can be read in continuity. Dynamic registers and fast transfer mode mailbox can be read in continuity, but not written in continuity. No password is needed to access dynamic registers.

The table below shows the complete map of dynamic registers, as seen by RF interface and by I<sup>2</sup>C interface.

**Table 14. Dynamic registers memory map**

RF access		Dynamic Registers		I <sup>2</sup> C access		
Address	Type	Name	Function	Device select	Address	Type
00h	RO	GPO_CTRL_Dyn	GPO control	E2=0, E1=1	2000h	R/W
No access		-	ST Reserved	E2=0, E1=1	2001h	RO
02h	R/W	EH_CTRL_Dyn	Energy Harvesting management & usage status	E2=0, E1=1	2002h	R/W
No access		RF_MNGT_Dyn	RF interface usage management	E2=0, E1=1	2003h	R/W
		I2C_SSO_Dyn	I <sup>2</sup> C security session status	E2=0, E1=1	2004h	RO
		IT_STS_Dyn	Interruptions Status	E2=0, E1=1	2005h	RO
0Dh	R/W	MB_CTRL_Dyn	Fast transfer mode control and status	E2=0, E1=1	2006h	R/W
NA	RO	MB_LEN_Dyn	Length of fast transfer mode message	E2=0, E1=1	2007h	RO

## 4.5 Fast transfer mode mailbox

ST25DVxxKC fast transfer mode uses a dedicated mailbox buffer for transferring messages between RF and I<sup>2</sup>C worlds. This mailbox contains up to 256 Bytes of data which are filled from the first byte.

Fast transfer mode mailbox is accessed in bytes from both RF and I<sup>2</sup>C.

In RF, mailbox is read via a dedicated (Fast) Read Message command. Read can start from any address value inside the mailbox, between 00h and FFh. Writing in the mailbox is done via the (Fast) Write Message command in one shot, always starting at mailbox address 00h. No password is needed to access mailbox from RF, but fast transfer mode must be enabled.

In I<sup>2</sup>C, mailbox read can start from any address value between 2008h and 2107h. Write mailbox MUST start from address 2008h to a max of 2107h. No password is needed to access mailbox from I<sup>2</sup>C, but fast transfer mode must be enabled.

The table below shows the map of fast transfer mode mailbox, as seen by RF interface and by I<sup>2</sup>C interface.

**Table 15. Fast transfer mode mailbox memory map**

RF access		Fast transfer mode buffer		I <sup>2</sup> C access		
Address	Type	Name	Function	Device select	Address	Type
00h	R/W	MB_Dyn Byte 0	Fast transfer mode buffer (256-Bytes)	E2=0, E1=1	2008h	R/W
01h	R/W	MB_Dyn Byte 1		E2=0, E1=1	2009h	R/W
...	...	...		E2=0, E1=1	...	...
FEh	R/W	MB_Dyn Byte 254		E2=0, E1=1	2106h	R/W
FFh	R/W	MB_Dyn Byte 255		E2=0, E1=1	2107h	R/W

## 5 ST25DVxxKC specific features

ST25DVxxKC offers the following features:

- A fast transfer mode (FTM), to achieve a fast link between RF and contact worlds, via a 256 byte buffer called Mailbox. This mailbox dynamic buffer of 256 byte can be filled or emptied via either RF or I<sup>2</sup>C.
- A GPO pin, which indicates incoming events to the contact side, like RF events (RF field changes, RF activity, Rf writing completion or mailbox message availability) or I<sup>2</sup>C events (I<sup>2</sup>C write completion, RF switch off from I<sup>2</sup>C).
- An Energy Harvesting element to deliver  $\mu$ W of power when external conditions make it possible.
- RF management, which allows ST25DVxxKC to ignore RF requests.

All these features can be programmed by setting static and/or dynamic registers of the ST25DVxxKC. ST25DVxxKC can be partially customized using configuration registers located in the system area.

These registers are:

- dedicated to Data Memory organization and protection ENDA<sub>i</sub>, I2CSS, RFAiSS, LOCK\_CCFILE.
- dedicated to fast transfer mode FTM
- dedicated to observation, GPO, IT\_TIME
- dedicated to RF , RF\_MNGT, EH\_MODE
- dedicated the device's structure LOCK\_CFG
- dedicated to I<sup>2</sup>C configuration, I2C\_CFG

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

### In I<sup>2</sup>C

Read accesses to the static configuration register is always allowed, except for passwords. For dedicated registers, write access is granted after prior successful presentation of the I<sup>2</sup>C password. Configuration register are located from address 0000h to 00FFh in the system area.

### In RF

Dedicated commands Read Configuration and Write Configuration must be used to access the static configuration registers. Update is only possible when the access right was granted by presenting the RF configuration password (RF\_PWD\_0), and if the system configuration was not previously locked by the I<sup>2</sup>C host (LOCK\_CFG=1), which acts as security master.

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

Some of the static registers have a dynamic image (notice \_Dyn) preset with the static register value: GPO\_CTRL\_Dyn, EH\_CTRL\_Dyn, RF\_MNGT\_Dyn and MB\_CTRL\_Dyn.

When it exists, ST25DVxxKC uses the dynamic configuration register to manage its processes. A dynamic configuration register updated by the application recovers its default static value after a Power On Reset (POR).

Other dynamic registers are dedicated to process monitoring:

- I2C\_SSO\_Dyn is dedicated to data memory protection
- MB\_LEN\_Dyn, MB\_CTRL\_Dyn are dedicated to fast transfer mode
- IT\_STS\_Dyn is dedicated to interrupt

In I<sup>2</sup>C, read and write of the Dynamic registers is done using usual I<sup>2</sup>C read & write command at dedicated address (E2=0 and E1=1 in device select).

In RF read or write accesses to the Dynamic registers are associated to the dedicated commands, Read Dynamic Configuration, Write Dynamic Configuration and Read Message Length.

## 5.1 Fast transfer mode (FTM)

### 5.1.1 Fast transfer mode registers

#### Static Registers

**Table 16. FTM access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @0Dh Write Configuration (cmd code A1h) @0Dh	R always, W if RF configuration security session is open and configuration not locked	E2=1, E1=1, 000Dh	R always, W if I <sup>2</sup> C security session is open

**Table 17. FTM**

Bit	Name	Function	Factory value
b0	MB_MODE	0: Enabling fast transfer mode is forbidden. 1: Enabling fast transfer mode is authorized.	0b
b3-b1	MB_WDG	Watchdog duration = $2^{MB\_WDG - 1} \times 30ms \pm 6$ If MD_WDG = 0, then watchdog duration is infinite	000b
b7-b4	RFU	-	0000b

Note: Refer to [Table 13. System configuration memory map for the FTM register](#).

#### Dynamic Registers

**Table 18. MB\_CTRL\_Dyn access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Dynamic Configuration (cmd code ADh) @0Dh Fast Read Dynamic Configuration (cmd code CDh) @0Dh Write Dynamic Configuration (cmd code AEh) @0Dh Fast Write Dynamic Configuration (cmd code CEh) @0Dh	b0: R always, W always b7-b1: RO	E2=0, E1=1, 2006h	b0: R always, W always b7-b1: RO

**Table 19. MB\_CTRL\_Dyn**

Bit	Name	Function	Factory value
b0	MB_EN <sup>(1)</sup>	0: Disable FTM, FTM mailbox is empty 1: Enable FTM	0b
b1	HOST_PUT_MSG	0: No I <sup>2</sup> C message in FTM mailbox 1: I <sup>2</sup> C has Put a message in FTM mailbox	0b
b2	RF_PUT_MSG	0: No RF message in FTM mailbox 1: RF has Put message in FTM mailbox	0b
b3	RFU	-	0b
b4	HOST_MISS_MSG	0: No message missed by I <sup>2</sup> C 1: I <sup>2</sup> C did not read RF message before watchdog time out	0b
b5	RF_MISS_MSG	0: No message missed by RF 1: RF did not read message before watchdog time out	0b
b6	HOST_CURRENT_MSG	0: No message or message not coming from I <sup>2</sup> C 1: Current Message in FTM mailbox comes from I <sup>2</sup> C	0b
b7	RF_CURRENT_MSG	0: No message or message not coming from RF 1: Current Message in FTM mailbox comes from RF	0b

1. MB\_EN bit is automatically reset to 0 if MB\_MODE bit in FTM register is reset to 0.

Note: Refer to Table 14. Dynamic registers memory map for the MB\_CTRL\_Dyn register.

**Table 20. MB\_LEN\_Dyn access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Message Length (cmd code ABh)	RO	E2=0, E1=1, 2007h	RO
Fast Read Message Length (cmd code CBh)			

**Table 21. MB\_LEN\_Dyn**

Bit	Name	Function	Factory value
b7-b0	MB_LEN	Size in byte, minus 1 byte, of message contained in FTM mailbox (automatically set by ST25DVxxKC)	0h

Note: Refer to Table 14. Dynamic registers memory map for the MB\_LEN\_Dyn register.

### 5.1.2 Fast transfer mode usage

ST25DVxxKC acts as mailbox between RF (reader, smartphone, ...) and an I<sup>2</sup>C host (microcontroller...). Each interface can send a message containing up to 256 bytes of data to the other interface through that mailbox.

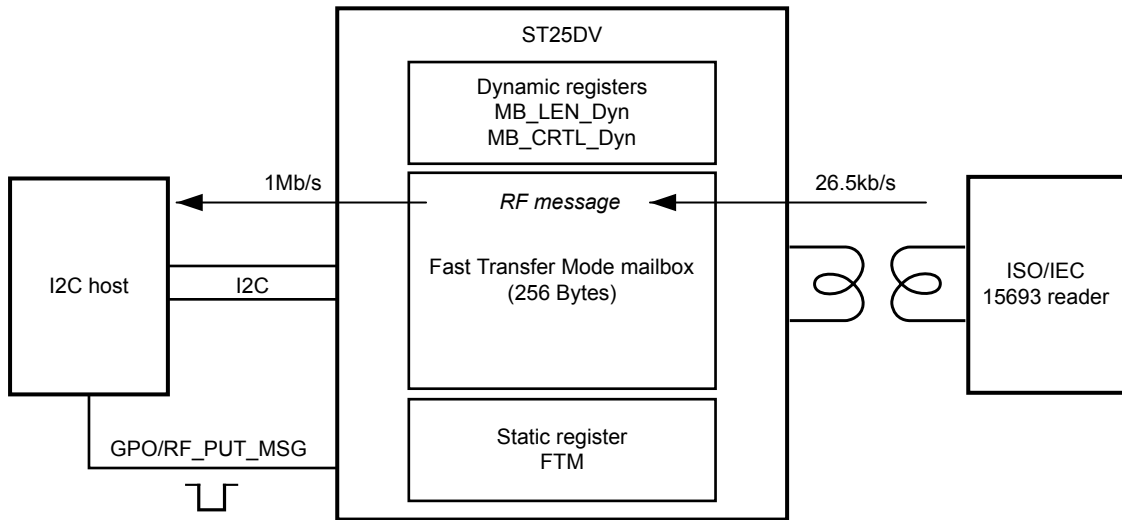
To send data from RF reader to I<sup>2</sup>C host, fast transfer mode must be enabled, the mailbox must be free, V<sub>CC</sub> power must be present, and the RF user must first writes the message containing data in the mailbox.

I<sup>2</sup>C host is then informed (by interruption on GPO output or polling on MB\_CTRL\_Dyn register) that a message from RF is present in the mailbox.

Once the complete message has been read by I<sup>2</sup>C, mailbox is considered free again and is available for receiving a new message (data is not cleared).

The RF user is informed that the message has been read by the I<sup>2</sup>C host by polling on MB\_CTRL\_Dyn register.



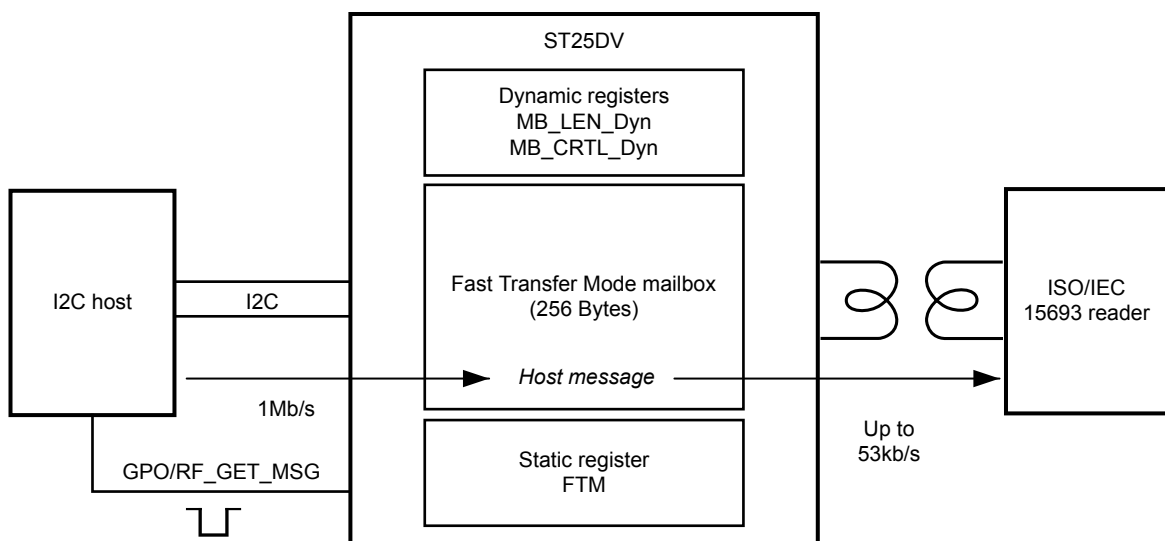
**Figure 11. RF to I<sup>2</sup>C fast transfer mode operation**


To send data from the I<sup>2</sup>C host to the RF reader, fast transfer mode must be enabled, the mailbox must be free, V<sub>CC</sub> power must be present, and the I<sup>2</sup>C host must first write the message containing data in the mailbox.

The RF user must poll on MB\_CTRL\_Dyn register to check for the presence of a message from I<sup>2</sup>C in the mailbox.

Once the complete message has been read by RF user, mailbox is considered free again and is available for receiving a new message (data is not cleared).

The I<sup>2</sup>C host is informed that message has been read by RF user through a GPO interruption or by polling on the MB\_CTRL\_Dyn register.

**Figure 12. I<sup>2</sup>C to RF fast transfer mode operation**


V<sub>CC</sub> supply source is mandatory to activate this feature.

No precedence rule is applied: the first request is served first.

Adding a message is only possible when fast transfer mode is enabled (MB\_EN=1) and mailbox is free (HOST\_PUT\_MSG and RF\_PUT\_MSG cleared, which is the case after POR or after complete reading of I<sup>2</sup>C message by RF, and complete reading of RF message by I<sup>2</sup>C).

A watchdog limits the message availability in time: when a time-out occurs, the mailbox is considered free, and the HOST\_MISS\_MSG or RF\_MISS\_MSG bits is set into MB\_CTRL\_Dyn register. The data contained in the mailbox is not cleared after a read or after the watchdog has been triggered: message data is still available for read and until fast transfer mode is disabled. HOST\_CURRENT\_MSG and RF\_CURRENT\_MSG bits are indicating the source of the current data.

The message is stored in a buffer (256 Bytes), and the write operation is done immediately. .

**Caution:** The data written in user memory (EEPROM), either from I<sup>2</sup>C or from RF, transits via the 256-Byte buffer. Consequently fast transfer mode must be deactivated (MB\_EN=0) before starting any write operation in user memory, otherwise the command is NotACK for I<sup>2</sup>C or get an answer 0Fh for RF and programming is not done.

### I<sup>2</sup>C access to mailbox

The access by I<sup>2</sup>C can be done by dedicated address mapping to mailbox (2008h to 2107h) with device select E2=0, E1=1.

I<sup>2</sup>C reading operation does not support rollover. Therefore data out is set to FFh when the counter reaches the message end.

The RF\_PUT\_MSG is cleared after reaching the STOP consecutive to reading the last message byte, and the mailbox is considered free (but the message is not cleared and it is still present in the mailbox) until a new message is written or mailbox is deactivated.

A I<sup>2</sup>C reading operation never deletes the HOST\_PUT\_MSG, and the message remains available for RF.

An I<sup>2</sup>C read can start at any address inside the mailbox (between address 2008h and 2107h).

A I<sup>2</sup>C write operation must start from the first mailbox location, at address 2008h. After reaching the Mailbox border at address 2107h all bytes are NACK and the command is not executed (no rollover).

At the end of a successful I<sup>2</sup>C message write, the message length is automatically set into MB\_LEN\_Dyn register, and HOST\_PUT\_MSG bit is set into MB\_CTRL\_Dyn register, and the write access to the mailbox is not possible until the mailbox has been released again. MB\_LEN\_Dyn contains the size of the message in byte, minus 1.

### RF access to mailbox

The RF Control & Access to mailbox is possible using dedicated custom commands:

- Read Dynamic Configuration and Fast Read Dynamic Configuration to check availability of mailbox.
- Write Dynamic Configuration and Fast Write Dynamic configuration to enable or disable fast transfer mode.
- Read Message Length and Fast Read Message Length to get the length of the contained message,
- Read Message and Fast Read Message to download the content of the mailbox,
- Write Message and Fast Write Message to put a new message in mailbox. (New length is automatically updated after completion of a successful Write Message or Fast Write Message command).

HOST\_PUT\_MSG is cleared following a valid reading of the last message byte, and mailbox is considered free (but message is not cleared and is still present in the mailbox) until a new message is written or mailbox is deactivated.

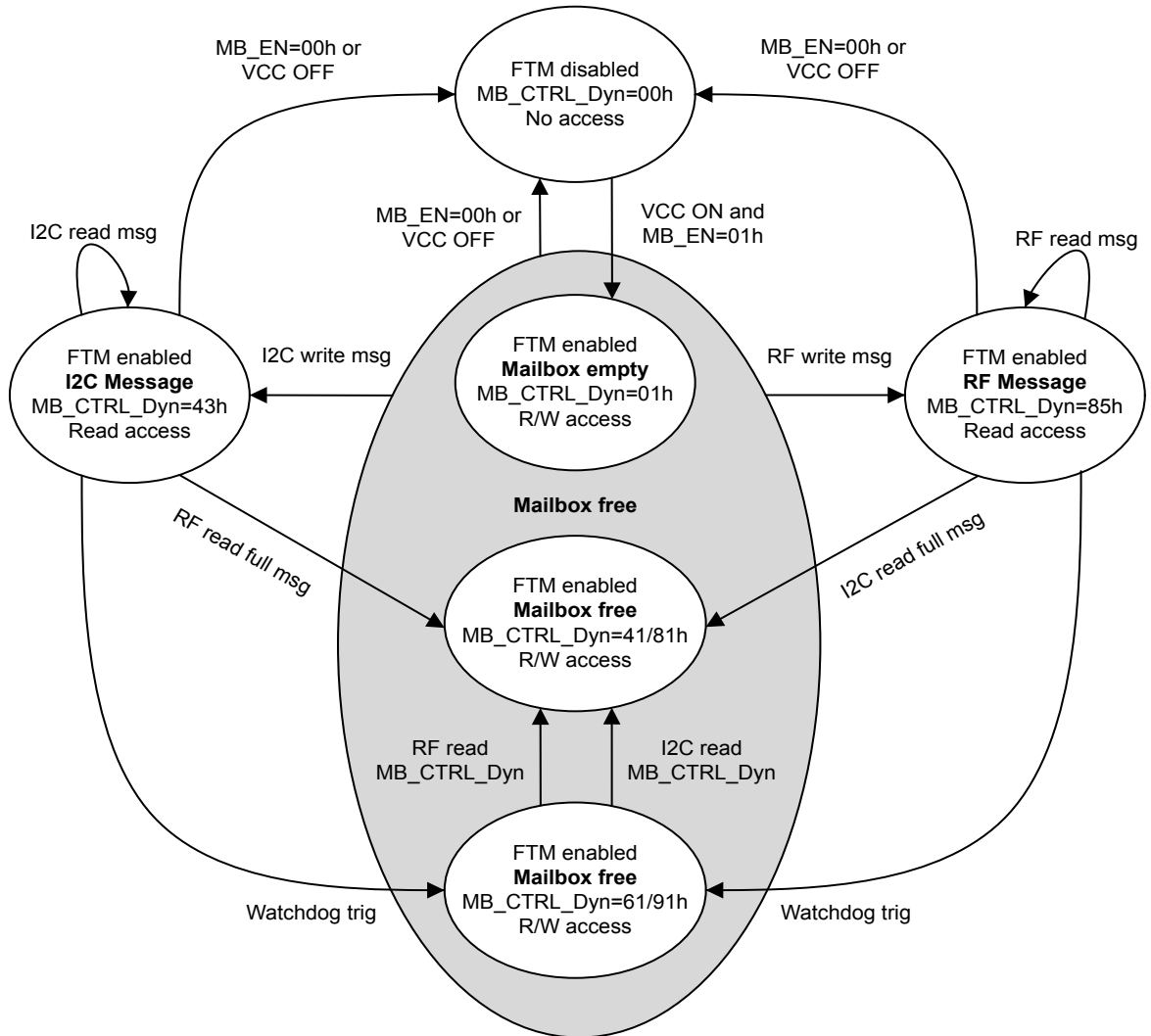
An RF read can start at any address of inside the message, but return an error 0Fh if trying to read after the last byte of the message.

An RF reading operation never deletes the RF\_PUT\_MSG and the message remains available for I<sup>2</sup>C.

At the end of a successful RF message write, the message length is automatically set in MB\_LEN\_Dyn register, and RF\_PUT\_MSG bit is set in MB\_CTRL\_Dyn register. and write access to the mailbox is not possible until mailbox has been freed again.

The presence of a DC supply is mandatory to get RF access to the mailbox. VCC\_ON can be checked reading the dynamic register EH\_CTRL\_Dyn.

To get more details about sequences to prepare and initiate a Fast Transfer, to detect progress of a fast transfer or to control and execute a fast transfer, please refer to AN4910. How to exchange data between wired (I<sup>2</sup>C) and wireless world (RF ISO15693) using fast transfer mode supported by ST25DVxxKC).

**Figure 13. Fast transfer mode mailbox access management.**


*Note:* Assuming MB\_MODE=1b  
Assuming no error occurred

## 5.2 RF management feature

### 5.2.1 RF management registers

**Table 22. RF\_MNGT access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @03h Write Configuration (cmd code A1h) @03h	R always, W if RF configuration security session is open and configuration not locked	E2=1, E1=1, 0003h	R always, W if I <sup>2</sup> C security session is open

**Table 23. RF\_MNGT**

Bit	Name	Function	Factory value
b0	RF_DISABLE	0: RF commands executed 1: RF commands not executed (error 0Fh returned)	0b
b1	RF_SLEEP	0: RF communication enabled 1: RF communication disabled (ST25DV remains silent)	0b
b7-b2	RFU	-	000000b

Note: Refer to [Table 13. System configuration memory map](#) for the RF\_MNGT register.

**Table 24. RF\_MNGT\_Dyn access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
No access		E2=0, E1=1, 2003h	R always, W always

**Table 25. RF\_MNGT\_Dyn**

Bit	Name	Function	Factory value
b0	RF_DISABLE	0: RF mode is defined by RF_OFF and RF_SLEEP bits 1: RF commands not executed (error 0Fh returned)	0b
b1	RF_SLEEP	0: RF mode is defined by RF_OFF and RF_DISABLE bits 1: RF communication disabled (ST25DVxxKC remains silent)	0b
b2	RF_OFF	0: RF mode is defined by RF_SLEEP and RF_DISABLE bits 1: RF is reset, and communication disabled (RF security sessions and ISO15693 state are reset and ST25DVxxKC remains silent)	0b
b7-b3	RFU	-	0000000b

Note: Refer to [Table 14. Dynamic registers memory map](#) for the RF\_MNGT\_Dyn register.

The RF\_OFF bit access is defined as followed:

- read only with user memory I<sup>2</sup>C slave address, followed by memory address of RF\_MNGT\_Dyn register.
- write to 1 only with I<sup>2</sup>C "RFSwitchOff" command.
- write to 0 only with I<sup>2</sup>C "RFSwitchOn" command.
- cannot be accessed by any other I<sup>2</sup>C slave address or by RF.

The RF\_DISABLE and RF\_SLEEP bits are accessible in Read and Write with the user memory I<sup>2</sup>C slave address, followed by memory address of RF\_MNGT\_Dyn register.

### 5.2.2 RF management feature description

RF communication capabilities between ST25DVxxKC and an RF reader can be controlled by configuring the RF mode. ST25DVxxKC offers four RF modes:

- RF normal mode (default mode)
- RF disable mode
- RF sleep mode
- RF off mode

The RF\_MNGT and RF\_MNGT\_Dyn registers are used to configure and control the RF mode.

At boot time, and each time the RF\_MNGT register is updated, content of RF\_MNGT\_Dyn register is copied from RF\_MNGT register.

The content of the dynamic register RF\_MNGT\_Dyn can be updated on the fly, to temporarily modify the behaviour of ST25DVxxKC without affecting the static value of RF\_MNGT register which is recovered at next POR.

#### RF normal mode:

In normal usage, and if I<sup>2</sup>C interface is not busy (see [Section 5.3 Interface arbitration](#)), the ST25DVxxKC processes the RF request and respond accordingly. In this mode, all bits of RF\_MNGT\_Dyn are set to 0.

#### RF disable mode:

In disable mode, RF commands are interpreted but not executed. In case of a valid command, the ST25DVxxKC responds after  $t_1$  with the error 0Fh, and stay mute to the Inventory command.

ISO15693 state and RF security sessions status are unchanged.

In this mode, bit 0 of RF\_MNGT\_Dyn, RF\_DISABLE, is set to 1 and all other bits are set to 0

#### RF sleep mode:

In sleep mode, all RF communication are disabled and RF interface doesn't interpret any RF commands.

ISO15693 state and RF security sessions status are unchanged.

In this mode, bit 1 of RF\_MNGT\_Dyn, RF\_SLEEP, is set to 1 and bit 2, RF\_OFF, is set to 0 (bit 0, RF\_DISABLE is don't care).

#### RF off mode:

In off mode, all RF communication are disabled and RF interface doesn't interpret any RF commands.

ISO15693 state is reset and RF security sessions are closed.

In this mode, bit 2 of RF\_MNGT\_Dyn, RF\_OFF, is set to 1 and other bits are don't care.

RF sleep and RF disable modes are controlled through writing in RF\_SLEEP and RF\_DISABLE bits in RF\_MNGT register from RF or I<sup>2</sup>C and RF\_MNGT\_Dyn register from I<sup>2</sup>C.

RF off mode is controlled exclusively from I<sup>2</sup>C. An I<sup>2</sup>C "RFSwitchOff" command allows to switch off the RF and an I<sup>2</sup>C "RFSwitchOn" command allows to switch on the RF. Entering RF off mode set the RF\_MNGT\_Dyn bit 2, RF\_OFF, to 1 (see [Section 5.3 Interface arbitration](#) for details on the I<sup>2</sup>C "RFSwitchOff" and I<sup>2</sup>C "RFSwitchOn" commands).

Different RF modes have priority levels: RF off mode has priority over RF sleep mode, which has priority over RF disable mode.

Effect of updating RF\_MNGT or RF\_MNGT\_Dyn registers is immediate.

Effect of I<sup>2</sup>C "RFSwitchOff" command can be immediate or be effective at the end of a write in progress in EEPROM memory, to avoid any data corruption. A pulse can be generated on GPO pin to indicate to the I<sup>2</sup>C host exactly when the ST25DVxxKC enters in RF off mode following a valid I<sup>2</sup>C "RFSwitchOff" command.

RF off mode can be exited with the I<sup>2</sup>C “RFSwitchOn” command, or by removing the VCC power supply. Exiting RF off mode reset the bit 2, RF\_OFF, of RF\_MNGT\_Dyn register. When exiting RF off mode, ST25DVxxKC state machine is set to Reset to Ready state, and all RF security sessions are closed.

**Table 26. RF modes summary**

RF mode	RF requests treatment	ISO15693 state	RF security sessions
Run	Executed normally	Changed by relevant RF requests	Changed by relevant RF requests
Disable	Not executed. Error 0Fh returned when possible	Unchanged	Unchanged
Sleep	Not processed, not answered	Unchanged	Unchanged
Off	Not processed, not answered	Reset (back to reset to ready state)	Reset (all sessions closed)

Following table is summarizing the effect of RF\_OFF, RF\_SLEEP and RF\_DISABLE bits, as well as I<sup>2</sup>C busy state on any RF request:

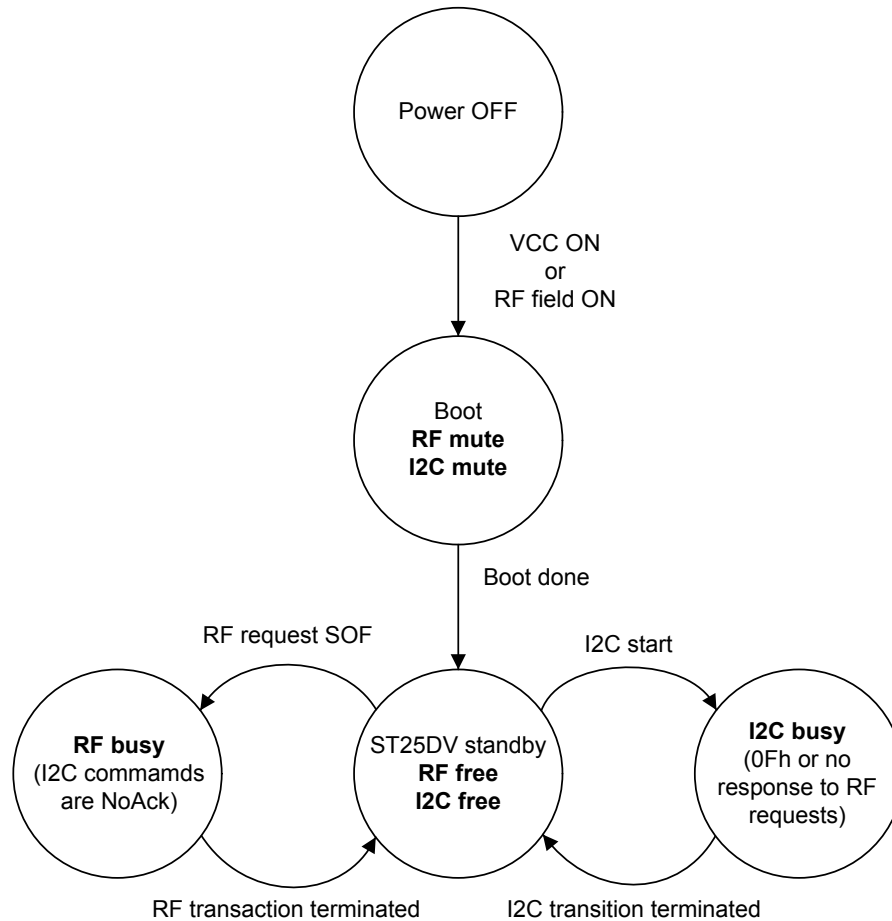
**Table 27. RF modes configuration bits and effect on RF requests**

RF_OFF	RF_SLEEP	RF_DISABLE	I <sup>2</sup> C busy	Effect on RF request
0	0	0	0	Processed
0	0	0	1	Not processed and answered with error 0Fh when possible
0	0	1	x	Not processed and answered with error 0Fh when possible
0	1	x	x	No processed, not answered
1	0	x	x	No processed, not answered
1	1	x	x	No processed, not answered

### 5.3 Interface arbitration

ST25DVxxKC automatically arbitrates the exclusive usage of RF and I<sup>2</sup>C interfaces. Arbitration scheme obeys to “first talk first served” basic law. (see Figure 14. ST25DVxxKC, Arbitration between RF and I<sup>2</sup>C).

Figure 14. ST25DVxxKC, Arbitration between RF and I<sup>2</sup>C



**RF transaction is terminated:**

- at response EOF if answer.
- at request EOF is no answer.
- at RF field OFF.

**I<sup>2</sup>C transaction is terminated:**

- at the end of EEPROM programming time after the stop condition of a successful write into EEPROM (user memory or system configuration). See Section 6.4 I<sup>2</sup>C Write operations for write time calculation
- at stop condition for any other I<sup>2</sup>C transaction
- at VCC power off
- at any I<sup>2</sup>C error (terminated before stop condition)
- at I<sup>2</sup>C timeout if it occurs

When RF is busy, I<sup>2</sup>C interface answers by NoAck on any I<sup>2</sup>C command.

When I<sup>2</sup>C is busy, RF commands receive no response (Inventory, Stay quiet, addressed commands) or error code 0Fh for any other command.

### 5.3.1 I<sup>2</sup>C priority

When RF is in sleep mode or in off mode, RF commands are not interpreted, and RF cannot be busy. I<sup>2</sup>C is then free to access the ST25DVxxKC exclusively.

Entering in RF sleep mode implies that I<sup>2</sup>C host writes into the RF\_MNGT\_Dyn register, which may not be possible immediately if RF is busy.

In case I<sup>2</sup>C host needs to get exclusive and immediate access to the ST25DVxxKC, an immediate (or as soon as possible) switch off (and on) of the RF interface is available.

A specific I<sup>2</sup>C “RFSwitchOff” command allows the I<sup>2</sup>C master to switch off RF immediately, or at the end of an RF write in progress in EEPROM, even if an RF command is ongoing.

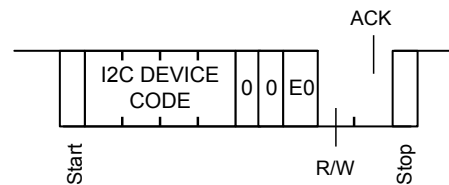
A specific I<sup>2</sup>C RFSwitchOn command allows the I<sup>2</sup>C master to switch on the RF immediately (RF returns to RF mode defined by RF\_MNGT\_Dyn register).

Bit 5 of the I2C\_CFG static register (I2C\_RF\_SWITCHOFF\_EN) allows to enable or disable the RF switch off and switch on from I<sup>2</sup>C.

The I<sup>2</sup>C “RFSwitchOff” command is defined as follow:

- START condition, followed by the I<sup>2</sup>C “RFSwitchOff” salve address (1 Byte), followed by acknowledge bit from the ST25DVxxKC, followed by STOP condition.
- See [Section 6.3 Device addressing](#) for I<sup>2</sup>C RFSwitchOff slave address value explanation.
- I<sup>2</sup>C “RFSwitchOff” salve address is not acknowledged only if I2C\_CFG register bit 5 (I2C\_RF\_SWITCHOFF\_EN) is set to 0 and is always acknowledged otherwise (even if RF is busy).

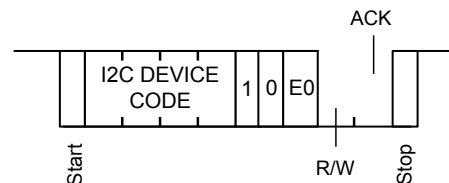
**Figure 15. I<sup>2</sup>C “RFSwitchOff” command**



The I<sup>2</sup>C RFSwitchOn command is defined as follow:

- START condition, followed by I<sup>2</sup>C “RFSwitchOn” salve address (1 Byte), followed by acknowledge bit from ST25DVxxKC, followed by STOP condition.
- See [Section 6.3 Device addressing](#) for I<sup>2</sup>C RFSwitchOn slave address value explanation.
- I<sup>2</sup>C “RFSwitchOn” salve address is not acknowledged only if I2C\_CFG register bit 5 (I2C\_RF\_SWITCHOFF\_EN) is set to 0 and is always acknowledged otherwise (even if RF is busy).

**Figure 16. I<sup>2</sup>C “RFSwitchOn” command**



When ST25DVxxKC receives the I<sup>2</sup>C “RFSwitchOff” command outside of any RF command processing, ST25DVxxKC is immediately setting the RF in off mode (see [Section 5.2.2 RF management feature description](#)). If GPO interruption RF\_OFF is enabled, a pulse is emitted on GPO pin after stop condition of the I<sup>2</sup>C “RFSwitchOff” command.

When ST25DVxxKC receives the I<sup>2</sup>C “RFSwitchOff” command concurrently to an RF command, two possible cases can happen:



- If there is a write in progress in EEPROM memory, following an RF write command execution, the RF is set in off mode at the completion of the write in memory. ST25DVxxKC does not answer to the RF request, but data is written into memory. If GPO interruption RF\_OFF is enabled, a pulse is emitted on GPO pin at end of all write programming cycles.
- If there is no write in progress in EEPROM memory, the RF is set in RF off mode immediately. ST25DVxxKC does not answer to the RF request. If GPO interruption RF\_OFF is enabled, a pulse is emitted on GPO pin after stop condition of the I<sup>2</sup>C “RFSwitchOff” command.

Once in RF off mode, I<sup>2</sup>C host get exclusive access to the ST25DVxxKC, whatever incoming RF requests (which are ignored).

## 5.4 GPO

GPO signal is used to alert the I<sup>2</sup>C host of external RF events or ST25DVxxKC processes activity and also if some specific I<sup>2</sup>C events. Several causes could be used to request a host interruption. RF user can also directly drive GPO pin level using a dedicated RF command.

### 5.4.1 ST25DVxxKC interrupt capabilities on RF events

ST25DVxxx supports multi interruption mode and can report several events occurring through RF interface.

In this section, all drawings are referring to the open drain version of GPO output (8-pin packages).

The reader can retrieve the behaviour of CMOS version (12-pin package) by inverting the GPO curve polarity and replace the word “released” or “high-Z” by “pull to ground”.

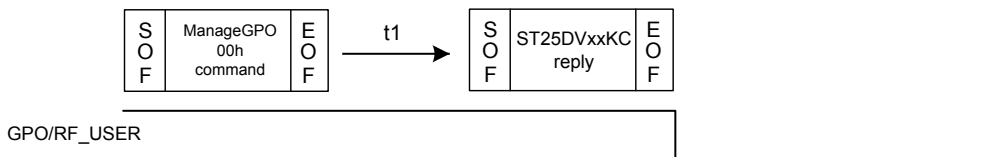
Supported RF events is listed hereafter:

**RF\_USER:**

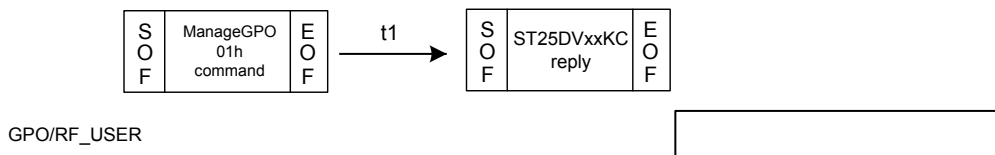
- GPO output level is controlled by Manage GPO command (set or reset)
- When RF\_USER is activated, GPO level is changed after EOF of ST25DVxxKC response to a Manage GPO set or reset command (see Section 7.6.30 Manage GPO).
- RF\_USER is prevalent over all other GPO events when set by Manage GPO command (other interrupts are still visible in IT\_STS\_Dyn status register, but do not change GPO output level).

**Figure 17. RF\_USER chronogram**

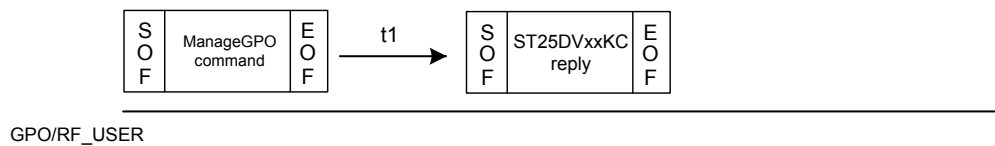
1) VCD sends a ManageGPO command with value 00h (set GPO) and ST25DVxxKC replies. GPO/RF\_USER is tied low after ST25DVxxKC response.



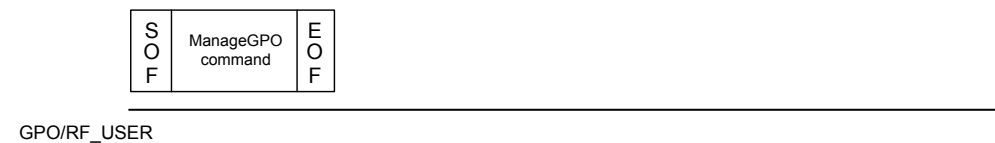
2) VCD sends a ManageGPO command with value 01h (reset GPO) and ST25DVxxKC replies. GPO/RF\_USER is set high-Z low after ST25DVxxKC response.



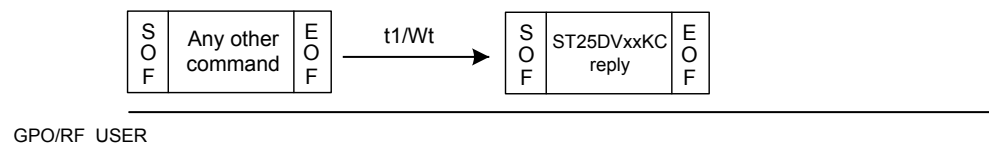
3) VCD sends a ManageGPO command (any value) and ST25DVxxKC replies with error. GPO/RF\_USER remains high-Z.



4) VCD sends a ManageGPO command (any value) and ST25DVxxKC stays quiet (command not for this VICC, or quiet state). GPO/RF\_USER remains high-Z.



5) VCD sends any command other than ManageGPO command and ST25DVxxKC replies. GPO/RF\_USER remains high-Z.

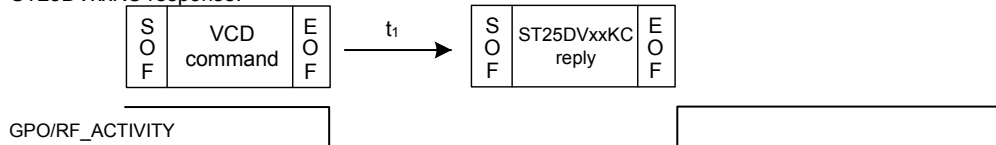


**RF\_ACTIVITY:**

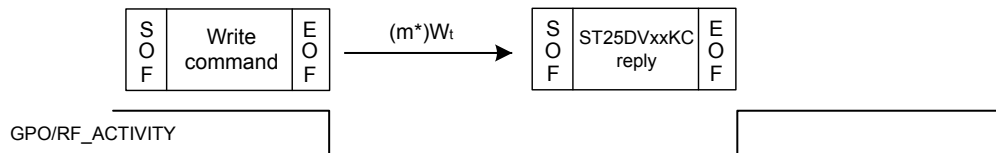
- GPO output level reflects the RF activity.
- When RF\_ACTIVITY is activated, a GPO output level change from RF command EOF to ST25DVxxKC response EOF.

**Figure 18. RF\_ACTIVITY chronogram**

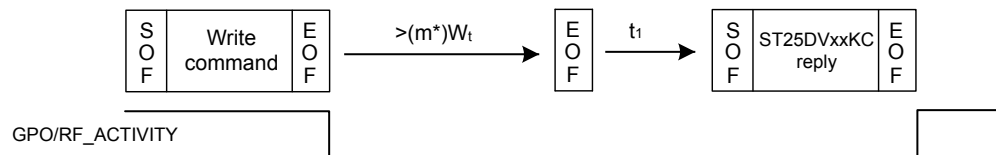
1) VCD sends a command and ST25DVxxKC replies. GPO/RF\_ACTIVITY is released after ST25DVxxKC response.



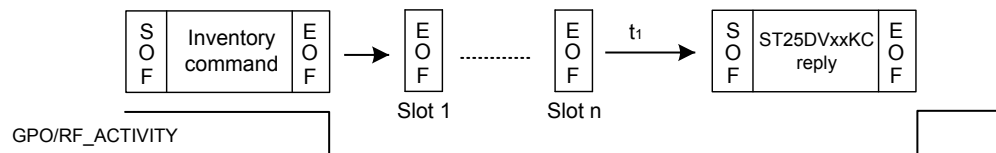
2) VCD sends a write command and ST25DVxxKC replies after write completed. GPO/RF\_ACTIVITY is released after ST25DVxxKC response.



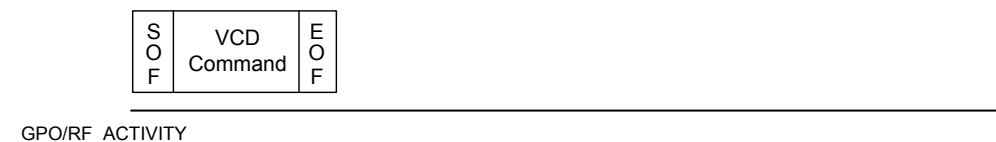
3) VCD sends a write command with option flag set to 1, and ST25DVxxKC replies after receiving EOF. GPO/RF\_ACTIVITY is released after ST25DVxxKC response.



4) VCD sends an Inventory 16 slots command, and ST25DVxxKC replies in its slot. GPO/RF\_ACTIVITY is released after ST25DVxxKC response.



5) VCD sends a command and ST25DVxxKC stays quiet (Stay Quiet command, command not for this VICC, or quiet state). GPO/RF\_ACTIVITY remains high-Z.

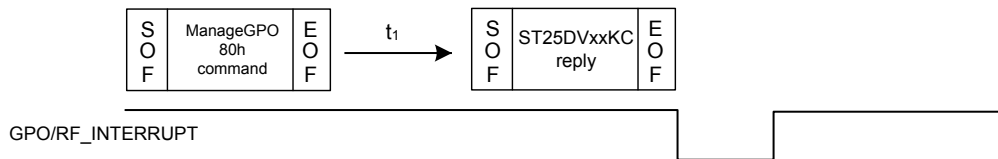


**RF\_INTERRUPT:**

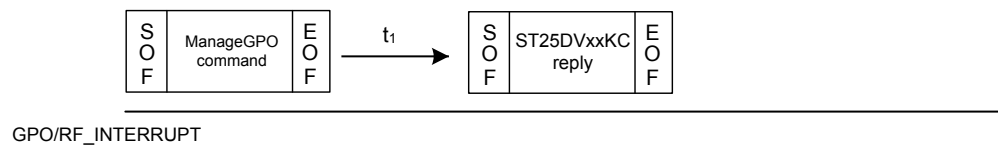
- A pulse is emitted on GPO by Manage GPO command (interrupt).
- When RF\_INTERRUPT is activated, a pulse of duration IT\_TIME is emitted after EOF of ST25DVxxKC response to a Manage GPO interrupt command (see Section 7.6.30 Manage GPO).

**Figure 19. RF\_INTERRUPT chronogram**

1) VCD sends a ManageGPO command with value 80h (GPO emit pulse) and ST25DVxxKC replies. GPO/RF\_INTERRUPT generates a pulse of duration IT\_TIME after ST25DVxxKC response.



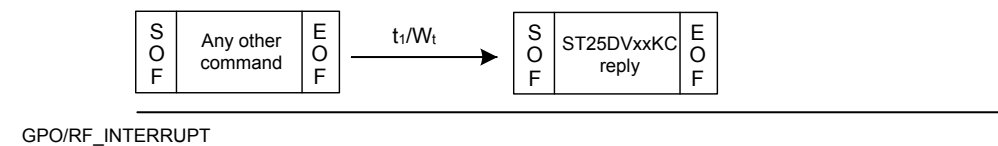
2) VCD sends a ManageGPO command (any value) and ST25DVxxKC replies with error. GPO/RF\_INTERRUPT remains high-Z.



3) VCD sends a ManageGPO command (any value) and ST25DVxxKC stays quiet (command not for this VICC, or quiet state). GPO/RF\_INTERRUPT remains high-Z.



4) VCD sends any command other than ManageGPO command and ST25DVxxKC replies. GPO/RF\_INTERRUPT remains high-Z.



**FIELD\_CHANGE:**

- A pulse is emitted on GPO to signal a change in RF field state.
- When FIELD\_CHANGE is activated, and when RF field appear or disappear, GPO emits a pulse of duration IT\_TIME.
- In case of RF field disappear, the pulse is emitted only if V<sub>CC</sub> power supply is present.
- If RF is configured in RF\_SLEEP mode or is in RF\_OFF state, field change are not reported on GPO, even if FIELD\_CHANGE event is activated, as shown in Table 28.

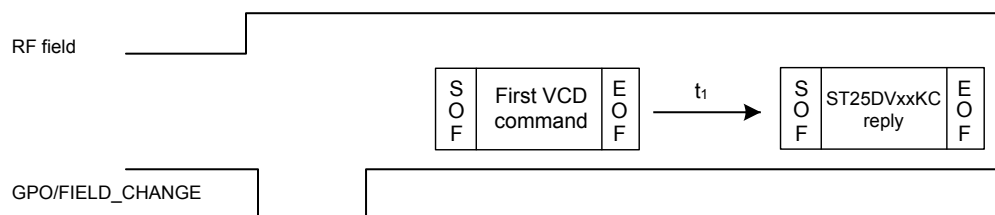
**Table 28. FIELD\_CHANGE when RF is disabled or in sleep or off mode**

RF_DISABLE	RF_SLEEP	RF_OFF	GPO behaviour when FIELD_CHANGE is enabled
0	0	0	A pulse is emitted on GPO if RF field appears or disappears <sup>(1)</sup>
1	0	0	IT_STS_Dyn register is updated.
X	1	X	GPO remains High-Z (open drain version) or is tied to ground (CMOS version).
X	X	1	IT_STS_Dyn register is not updated.

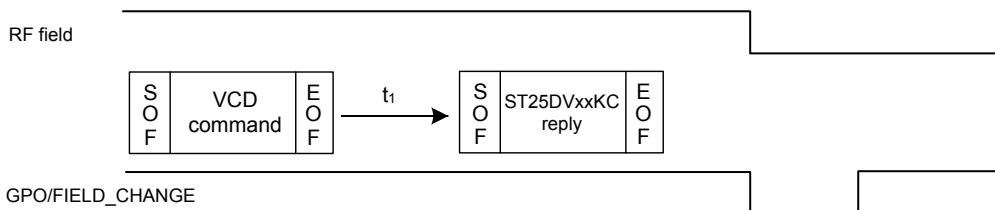
1. assuming that GPO output is enabled (GPO\_EN = 1).

**Figure 20. FIELD\_CHANGE chronogram**

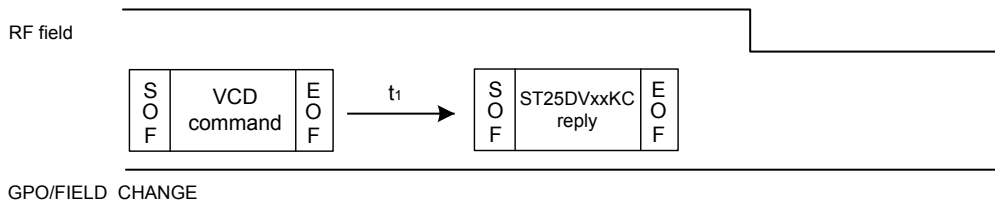
1) RF field appears. GPO/FIELD\_CHANGE generates a pulse during IT\_TIME.



2) RF field disappears and ST25DVxxKC is powered through VCC. GPO/FIELD\_CHANGE generates a pulse during IT\_TIME.



3) RF field disappears and ST25DVxxKC is not powered through VCC. GPO/FIELD\_CHANGE doesn't generate any pulse.

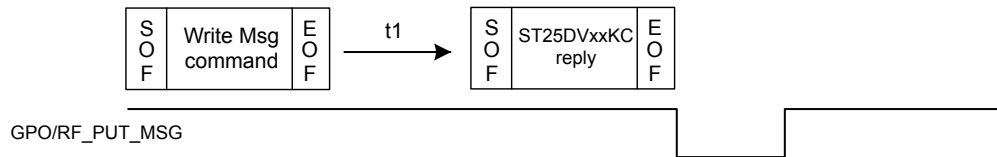


**RF\_PUT\_MSG:**

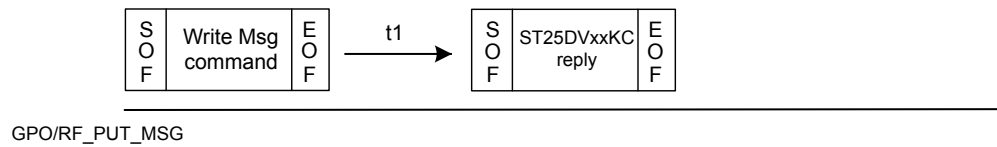
- A pulse is emitted on GPO when a message is successfully written by RF in fast transfer mode mailbox.
- When RF\_PUT\_MSG is activated, a pulse of duration IT\_TIME is emitted on GPO at completion of valid Write Message or Fast Write Message commands (after EOF of ST25DVxxKC response).

**Figure 21. RF\_PUT\_MSG chronogram**

- 1) VCD sends a Write Message or Fast Write Message command and ST25DVxxKC replies with no error. GPO/RF\_PUT\_MSG generates a pulse during IT\_TIME after ST25DVxxKC response.



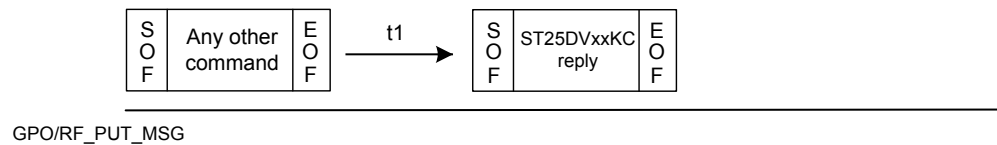
- 2) VCD sends a Write Message or Fast Write Message command and ST25DVxxKC replies with error. GPO/RF\_PUT\_MSG remains high-Z.



- 3) VCD sends Write Message or Fast Write Message command and ST25DVxxKC stays quiet (command not for this VICC, or quiet state). GPO/RF\_PUT\_MSG stays high-Z.



- 4) VCD sends a any other command than Write Message or Fast Write Message commands and ST25DVxxKC replies. GPO/RF\_PUT\_MSG remains high-Z.

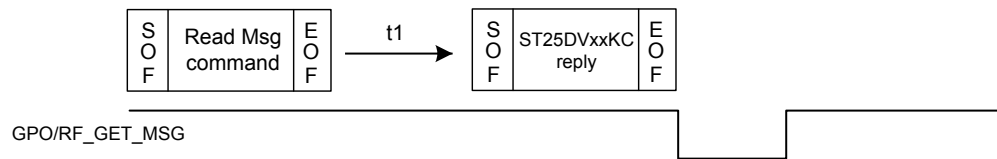


**RF\_GET\_MSG:**

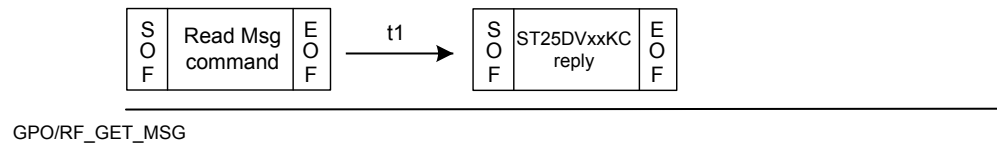
- A pulse is emitted on GPO when RF has successfully read a message, up to its last byte, in fast transfer mode mailbox.
- When RF\_GET\_MSG is activated, a pulse of duration IT\_TIME is emitted on GPO at completion of valid Read Message or Fast Read Message commands (after EOF of ST25DVxxKC response), and end of message has been reached.

**Figure 22. RF\_GET\_MSG chronogram**

1) VCD sends a Read Message or Fast Read Message command and ST25DVxxKC replies with no error. GPO/RF\_GET\_MSG generates a pulse during IT\_TIME after ST25DVxxKC response.



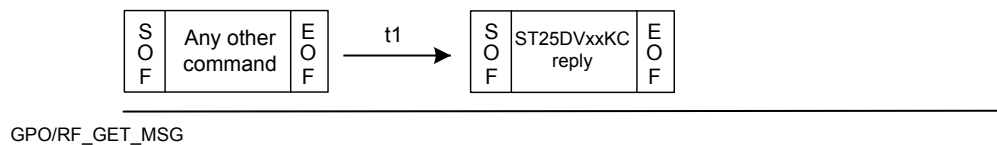
2) VCD sends a Read Message or Fast Read Message command and ST25DVxxKC replies with error. GPO/RF\_GET\_MSG remains high-Z.



3) VCD sends Read Message or Fast Read Message command and ST25DVxxKC stays quiet (command not for this VICC, or quiet state). GPO/RF\_GET\_MSG stays high-Z.



4) VCD sends any other command than Read Message or Fast Read Message commands and ST25DV replies. GPO/RF\_GET\_MSG remains high-Z.

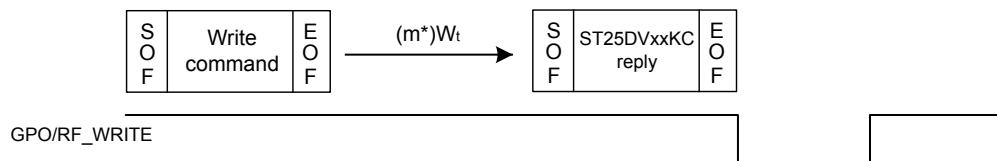


**RF\_WRITE:**

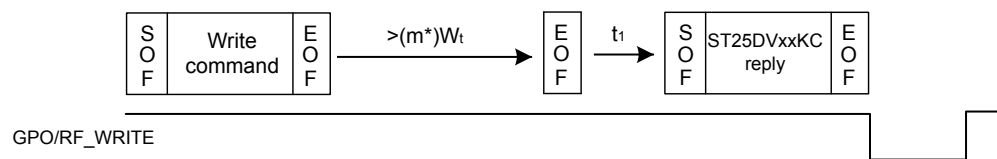
- When RF\_WRITE is activated, a pulse of duration IT\_TIME is emitted at completion of a valid RF write operation in EEPROM (after EOF of ST25DVxxKC response).
- Following commands trigger the RF\_WRITE interrupt after a valid write operation in EEPROM:
  - Write Single Block
  - Extended Write Single Block
  - Write Multiple Block
  - Extended Write Multiple Block
  - Lock Block
  - Extended Lock Block
  - Write AFI
  - Lock AFI
  - Write DSFID
  - Lock DSFID
  - Write Configuration
  - Write Password
- Note that writing in dynamic registers or fast transfer mode mailbox does not trigger RF\_WRITE interrupt (no write operation in EEPROM).

**Figure 23. RF\_WRITE chronogram**

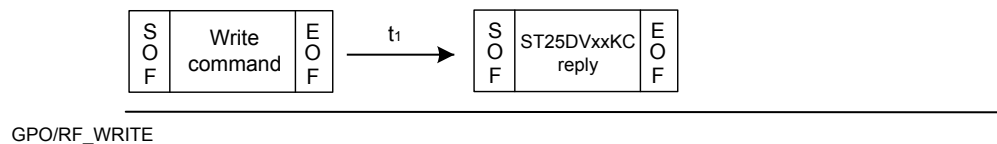
- 1) VCD sends a write command and ST25DVxxKC replies after write completed.  
GPO/RF\_WRITE generates a pulse during IT\_TIME after ST25DVxxKC response.



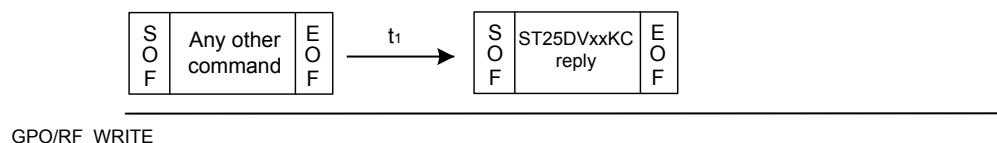
- 2) VCD sends a write command with option flag set to 1, and ST25DVxxKC replies after receiving EOF.  
GPO/RF\_WRITE generates a pulse during IT\_TIME after ST25DV response.



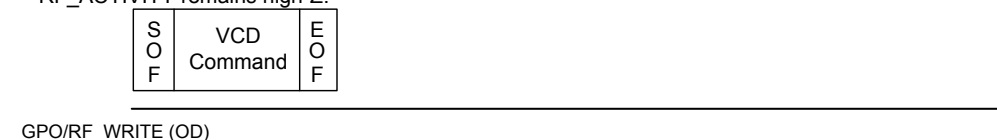
- 3) VCD sends a write command and ST25DV GPO/RF\_ replies with error.  
GPO/RF\_WRITE remains high-Z.



- 4) VCD sends any other command than a write command. GPO/RF\_WRITE remains high-Z.



- 5) VCD sends any command and ST25DV GPO/RF\_ stays quiet (command not for this VICC, or quiet state).  
RF\_ACTIVITY remains high-Z.





### 5.4.2 ST25DVxxKC interrupt capabilities on I<sup>2</sup>C events

On top of RF events, the ST25DVxxKC provides two additional I<sup>2</sup>C events that can trigger an interrupt on the GPO pin.

In this section, all drawings are referring to the open drain version of GPO output (8-pin packages).

The reader can retrieve the behaviour of CMOS version (12-pin package) by inverting the GPO curve polarity and replace the word “released” or “high-Z” by “pull to ground”.

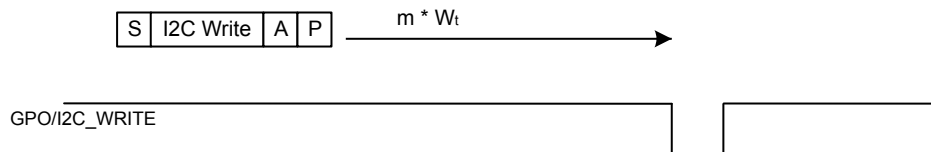
Supported I<sup>2</sup>C events is listed hereafter:

#### I2C\_WRITE:

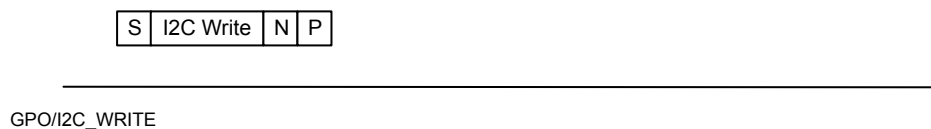
- When I2C\_WRITE is activated, a pulse of duration IT\_TIME is emitted at completion of a valid I<sup>2</sup>C write operation in EEPROM (after I<sup>2</sup>C STOP condition).
- Note that writing in dynamic registers or fast transfer mode mailbox does not trigger I2C\_WRITE interrupt (no write operation in EEPROM).
- The purpose of this GPO interrupt is to inform the I<sup>2</sup>C host when the I<sup>2</sup>C write programming cycle in EEPROM is completed, meaning the I<sup>2</sup>C bus and RF interface are free for new operation.

Figure 24. GPO/I2C\_WRITE chronogram

1) I2C host sends a valid write command to EEPROM. ST25DVxxKC program the data into EEPROM. GPO/I2C\_WRITE generates a pulse during IT\_TIME after programming cycle completion.



2) I2C host sends an invalid write command to EEPROM. ST25DVxxKC does not program the data into EEPROM. GPO/I2C\_WRITE remains High-Z.



3) I2C host sends a valid write command to Dynamic register or Mailbox. ST25DVxxKC program the data with no programming cycle. GPO/I2C\_WRITE remains high-Z.

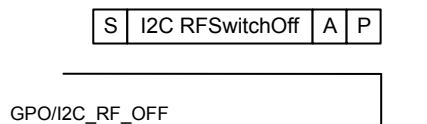


**I2C\_RF\_OFF:**

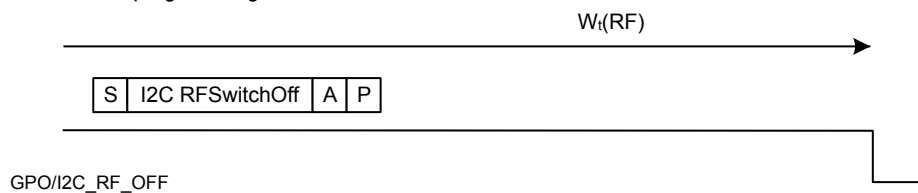
- When I2C\_RF\_OFF is activated, a pulse of duration IT\_TIME is emitted:
  - after the I<sup>2</sup>C STOP condition of a successful I<sup>2</sup>C “RFSwitchOff” command if no RF write to EEPROM is ongoing.
  - after the end of all blocks programming if the STOP condition of a successful I<sup>2</sup>C “RFSwitchOff” command happens during an RF write to EEPROM.
- The purpose of this GPO interrupt is to inform the I<sup>2</sup>C master when the I<sup>2</sup>C RFSwitchOff command has switched off the RF (RF is in off mode), as the timing action of the I<sup>2</sup>C RFSwitchOff can vary if an EEPROM write from RF is ongoing.

**Figure 25. GPO/I2C\_RF\_OFF chronogram**

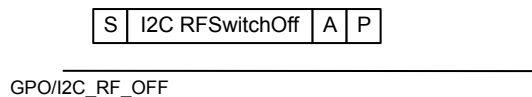
1) I2C host sends a valid I2C RFSwitchOff command and there is no write in progress to EEPROM memory from RF. RF is switched off immediately and GPO/I2C\_RF\_OFF generates a pulse during IT\_TIME after I2C STOP condition.



2) I2C host sends a valid I2C RFSwitchOff command and there is a write in progress to EEPROM memory from RF. RF is switched off and GPO/I2C\_RF\_OFF generates a pulse during IT\_TIME at end of EEPROM programming.



3) I2C host sends a valid I2C RFSwitchOff command and I2C\_RF\_SWITCHOFF\_EN = 0. RF is not switched off and the GPO/I2C\_RF\_OFF remains high-Z.


**5.4.3 GPO and power supply**

When at the same time RF field is present and V<sub>CC</sub> is ON, GPO is acting as configured in GPO1, GPO2 and GPO\_CTRL\_Dyn registers and both RF events and I<sup>2</sup>C events are reflected to the GPO pin.

When V<sub>CC</sub> is ON and no RF field is present, GPO is acting as configured in GPO2 and GPO\_CTRL\_Dyn registers, Only I<sup>2</sup>C events are reflected on the GPO pin. IT\_STS\_Dyn register is maintained unchanged until next I<sup>2</sup>C read of VCC power off.

When RF field is present and V<sub>CC</sub> is OFF, GPO is acting as configured in GPO1 (and GPO2 for IT\_TIME configuration only) and GPO\_CTRL\_Dyn registers. Only RF events are reflected on the GPO pin (assuming pull-up resistor is supplied with correct voltage for open drain version, or V<sub>DCG</sub> voltage is supplied for CMOS version). Exception is FIELD\_CHANGE when RF field is falling, which can't be reported on GPO output if V<sub>CC</sub> is off (no power supply on ST25DVxxKC).

**Table 29. GPO interrupt capabilities in function of RF field and V<sub>CC</sub>**

RF field	V <sub>CC</sub>	LPD	GPIO pin
OFF	OFF	Don't care	Remains High-Z (open drain version) or is tied to ground (CMOS version)
ON	OFF	Don't care	State is function of RF events <sup>(1)(2)</sup>
OFF	ON	High	Remains High-Z (open drain version) or is tied to ground (CMOS version)
ON	ON	High	State is function of RF events <sup>(1)(2)</sup>
OFF	ON	Low/unconnected	State function of I <sup>2</sup> C events
ON	ON	Low/unconnected	State is function of both RF and I <sup>2</sup> C event <sup>(1)</sup>

1. If pull-up resistor is powered (open drain) or VDCG is powered (CMOS)

2. Except FIELD\_CHANGE in case of RF field falling

#### 5.4.4 GPO registers

Four registers are dedicated to this feature:

- Two static registers in system configuration
- Two dynamic registers

**Table 30. GPO1 access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @00h	R always, W if RF configuration security session is open and configuration not locked	E2=1, E1=1, 0000h	R always, W if I <sup>2</sup> C security session is open
Write Configuration (cmd code A1h) @00h			

**Table 31. GPO1**

Bit	Name	Function	Factory value
b0	GPO_EN	0: GPO output is disabled. GPO is High-Z (open drain version) or is tied to ground (CMOS version). 1: GPO output is enabled. GPO outputs enabled interrupts.	1b
b1	RF_USER_EN	0: disabled 1: GPO output level is controlled by Manage GPO Command (set/reset).	0b
b2	RF_ACTIVITY_EN	0: disabled 1: GPO output level changes from RF command EOF to response EOF.	0b
b3	RF_INTERRUPT_EN	0: disabled 1: GPO output level is controlled by Manage GPO Command (pulse).	0b
b4	FIELD_CHANGE_EN	0: disabled 1: A pulse is emitted on GPO, when RF field appears or disappears.	1b
b5	RF_PUT_MSG_EN	0: disabled 1: A pulse is emitted on GPO at completion of valid RF Write Message command.	0b
b6	RF_GET_MSG_EN	0: disabled 1: A pulse is emitted on GPO at completion of valid RF Read Message command if end of message has been reached.	0b
b7	RF_WRITE_EN	0: disabled 1: A pulse is emitted on GPO at completion of valid RF write operation in EEPROM.	0b

**Note:** Refer to [Table 13. System configuration memory map for the GPO1 register](#):

- Enables the interruption source, and enable GPO output.
- Several interruption sources can be enabled simultaneously.
- The updated value is valid for the next command (except for the *RF\_WRITE* interrupt, which is valid right after EOF of the Write Configuration command if enabled through RF).
- The *GPO\_EN* bit (b0) is used to disable GPO output. The interruptions are still reported in *STS\_Dyn* register.
- RF configuration security session (present RF password 0) or I<sup>2</sup>C security session (present I<sup>2</sup>C password) must be open in order to write the GPO1 register.

**Table 32. GPO2 access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @01h	R always, W if RF configuration security session is open and configuration not locked	E2=1, E1=1, 0001h	R always, W if I <sup>2</sup> C security session is open
Write Configuration (cmd code A1h) @01h			

**Table 33. GPO2**

Bit	Name	Function	Factory value
b7-b5	RFU	-	000b
b4-b2	IT_TIME	Pulse duration = 301 us - IT_TIME x 37.65 us ± 2 us	011b
b1	I2C_RF_OFF_EN	0: disabled 1: A pulse is emitted on GPO when I <sup>2</sup> C host has successfully switched the RF off.	0b
b0	I2C_WRITE_EN	0: disabled 1: A pulse is emitted on GPO at completion of valid I <sup>2</sup> C write operation in EEPROM	0b

Note: Refer to [Table 13. System configuration memory map](#) for the GPO2 register.

- Defines interrupt pulse duration on GPO pin for the flowing events: RF\_INTERRUPT, FIELD\_CHANGE, RF\_PUT\_MSG, RF\_GET\_MSG, RF\_WRITE, I2C\_RF\_OFF\_EN and I2C\_WRITE\_EN.
- See [Eq. \(1\)](#) for interrupt duration calculation.

**Table 34. GPO\_CTRL\_Dyn access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Dynamic Configuration (cmd code ADh) @00h	RO	E2=0, E1=1, 2000h	b7-b1: RO
Fast Read Dynamic Configuration (cmd code CDh) @00h			b0 : R always, W always

**Table 35. GPO\_CTRL\_Dyn**

Bit	Name	Function	Factory value
b7-b1	RFU	-	0000000b
b0	GPO_EN	0: GPO output is disabled. GPO is High-Z (open drain version) or is tied to ground (CMOS version). 1: GPO output is enabled. GPO outputs enabled interrupts.	1b

Note: Refer to [Table 14. Dynamic registers memory map](#) for the GPO\_CTRL\_Dyn register.

- Allows I<sup>2</sup>C host to dynamically enable or disable GPO output by writing in GPO\_EN bit (b0).
- GPO\_EN bit of GPO\_CTRL\_Dyn register is prevalent over GPO\_EN bit of GPO register.
- At power up, and each time GPO register is updated, GPO\_EN bit content is copied from GPO register.
- GPO\_CTRL\_Dyn is a volatile register. Value is maintained only if at least one of the two power sources is present (RF field or V<sub>CC</sub>).
- GPO\_CTRL\_Dyn bit 0 (GPO\_EN) can be written even if I<sup>2</sup>C security session is closed (I<sup>2</sup>C password not presented) but is read only for RF user.
- Modifying GPO\_CTRL\_Dyn bit 0 (GPO\_EN), does not affect the value of GPO register bit 0 GPO\_EN

**Table 36. IT\_STS\_Dyn access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
No access		E2=0, E1=1, 2005h	RO

Table 37. IT\_STS\_Dyn

Bit	Name	Function	Factory value
b0	RF_USER	0: Manage GPO reset GPO 1: Manage GPO set GPO	0b
b1	RF_ACTIVITY	0: No RF access 1: RF access	0b
b2	RF_INTERRUPT	0: No Manage GPO interrupt request 1: Manage GPO interrupt request	0b
b3	FIELD_FALLING	0: No RF field falling 1: RF Field falling	0b
b4	FIELD_RISING	0: No RF field rising 1: RF field rising	0b
b5	RF_PUT_MSG	0: No message put by RF in FTM mailbox 1: Message put by RF in FTM mailbox	0b
b6	RF_GET_MSG	0: No message read by RF from FTM mailbox 1: Message read by RF from FTM mailbox, and 'end of message' reached	0b
b7	RF_WRITE	0: No write in EEPROM 1: Write in EEPROM	0b

Note: Refer to [Table 14. Dynamic registers memory map for the IT\\_STS\\_Dyn register.](#)

- Cumulates all events which generate interruptions. It should be checked by I<sup>2</sup>C host to know which event triggered an interrupt on GPO pin.
- When enabled, RF events are reported in IT\_STS\_Dyn register even if GPO output is disabled though the GPO\_EN bit.
- Once read the ITSTS\_Dyn register is cleared (set to 00h).
- At power up, IT\_STS\_Dyn content is cleared (set to 00h).
- IT\_STS\_Dyn is a volatile register. Value is maintained only if at least one of the two power sources is present (RF field or V<sub>CC</sub>).

### 5.4.5 Configuring GPO

GPO and interruption pulse duration can be configured by RF user or by I<sup>2</sup>C host. One or more interrupts can be enabled at same time.

RF user can use Read Configuration and Write Configuration commands to set accordingly the GPO1 and GPO2 registers, after presenting a valid RF configuration password to open RF configuration security session.

I<sup>2</sup>C host can write GPO1 and GPO2 registers, after presenting a valid I<sup>2</sup>C password to open I<sup>2</sup>C security session. Enabling or disabling GPO output:

- RF user and I<sup>2</sup>C host can disable or enable GPO output at power up time by writing in GPO\_EN bit 0 of GPO1 register (if write access is granted).
- I<sup>2</sup>C host can temporarily enable or disable GPO output at any time by toggling GPO\_EN bit 0 of GPO\_CTRL\_Dyn register. No password is required to write into GPO\_CTRL\_Dyn register.
- Disabling GPO output by writing in GPO\_EN bit (either in GPO1 or in GPO\_CTRL\_Dyn registers) does not disable interruption report in IT\_STS\_Dyn status register.

**Table 38. Enabling or disabling GPO interruptions**

GPO1 bit 0: GPO_EN	GPO_CTRL_Dyn bit 0: GPO_EN	GPO output
0	0	GPO remains High-Z (open drain version) or is tied to ground (CMOS version).
1	0	GPO remains High-Z (open drain version) or is tied to ground (CMOS version).
0	1	Activated RF and I <sup>2</sup> C events are reported on GPO output. <sup>(1)</sup>
1	1	Activated RF and I <sup>2</sup> C events are reported on GPO output. <sup>(1)</sup>

1. If pull-up resistor is powered (open drain version) or V<sub>DCG</sub> is powered (CMOS version).

Interruption pulse duration configuration:

- Interrupt pulse duration is configured by writing pulse duration value in bits 4 to 2 (IT\_TIME) of GPO2 register
- Pulse duration is calculated with the following equation

IT pulse duration equation:

$$IT_{pulse\ duration} = 301\mu s - IT\_TIME \times 37.65\mu s \pm 2\mu s \quad (1)$$

## 5.5 Energy harvesting (EH)

### 5.5.1 Energy harvesting registers

Table 39. EH\_MODE access

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @02h	R always, W if RF configuration security session is open and configuration not locked	E2=1, E1=1, 0002h	R always, W if I <sup>2</sup> C security session is open
Write Configuration (cmd code A1h) @02h			

Table 40. EH\_MODE

Bit	Name	Function	Factory value
b0	EH_MODE	0: EH forced after boot 1: EH on demand only	1b
b7-b1	RFU	-	0000000b

Note: Refer to Table 13. System configuration memory map for the EH\_MODE register.

Table 41. EH\_CTRL\_Dyn access

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Dynamic Configuration (cmd code ADh) @02h	b0: R always, W always b1 - b7: RO	E2=0, E1=1, 2002h	b0: R always, W always b1-b7 : RO
Fast Read Dynamic Configuration (cmd code CDh) @02h			
Write Dynamic Configuration (cmd code AEh) @02h			
Fast Write Dynamic Configuration (cmd code CEh) @02h			

Table 42. EH\_CTRL\_Dyn

Bit	Name	Function	Factory value
b0	EH_EN	0: Disable EH feature 1: Enable EH feature	0b
b1	EH_ON	0: EH feature is disabled 1: EH feature is enabled	0b
b2	FIELD_ON	0: RF field is not detected 1: RF field is present and ST25DVxxKC may communicate in RF	Depending of power source
b3	VCC_ON	0: No DC supply detected on V <sub>CC</sub> pin or Low Power Down mode is forced (LPD is high) 1: V <sub>CC</sub> supply is present and Low Power Down mode is not forced (LPD is low)	Depending of power source
b7-b4	RFU	-	0b

Note: Refer to Table 14. Dynamic registers memory map for the EH\_CTRL\_Dyn register.



### 5.5.2 Energy harvesting feature description

The usage of Energy Harvesting element can be defined in configuration register EH\_MODE. When the Energy harvesting mode is disabled or the RF field strength is not sufficient, the energy harvesting analog voltage output V\_EH is in High-Z state.

EH\_MODE Static Register is used to define the Energy Harvesting default strategy after boot.

At boot EH\_EN (in EH\_CTRL\_Dyn register) is set depending EH\_MODE value as shown in table below:

**Table 43. Energy harvesting at power-up**

EH_MODE	EH_EN (at boot)	Energy harvesting at power-up
0	1	EH enabled after boot (when possible)
1	0	EH disabled initially, EH delivered on demand (when possible)

Writing 0 in EH\_MODE at any time after boot automatically sets EH\_EN bit to 1, and thus activate energy harvesting.

Writing 1 in EH\_MODE at any time after boot does not modify EH\_EN bit (until next reboot) and thus does not modify energy harvesting current state.

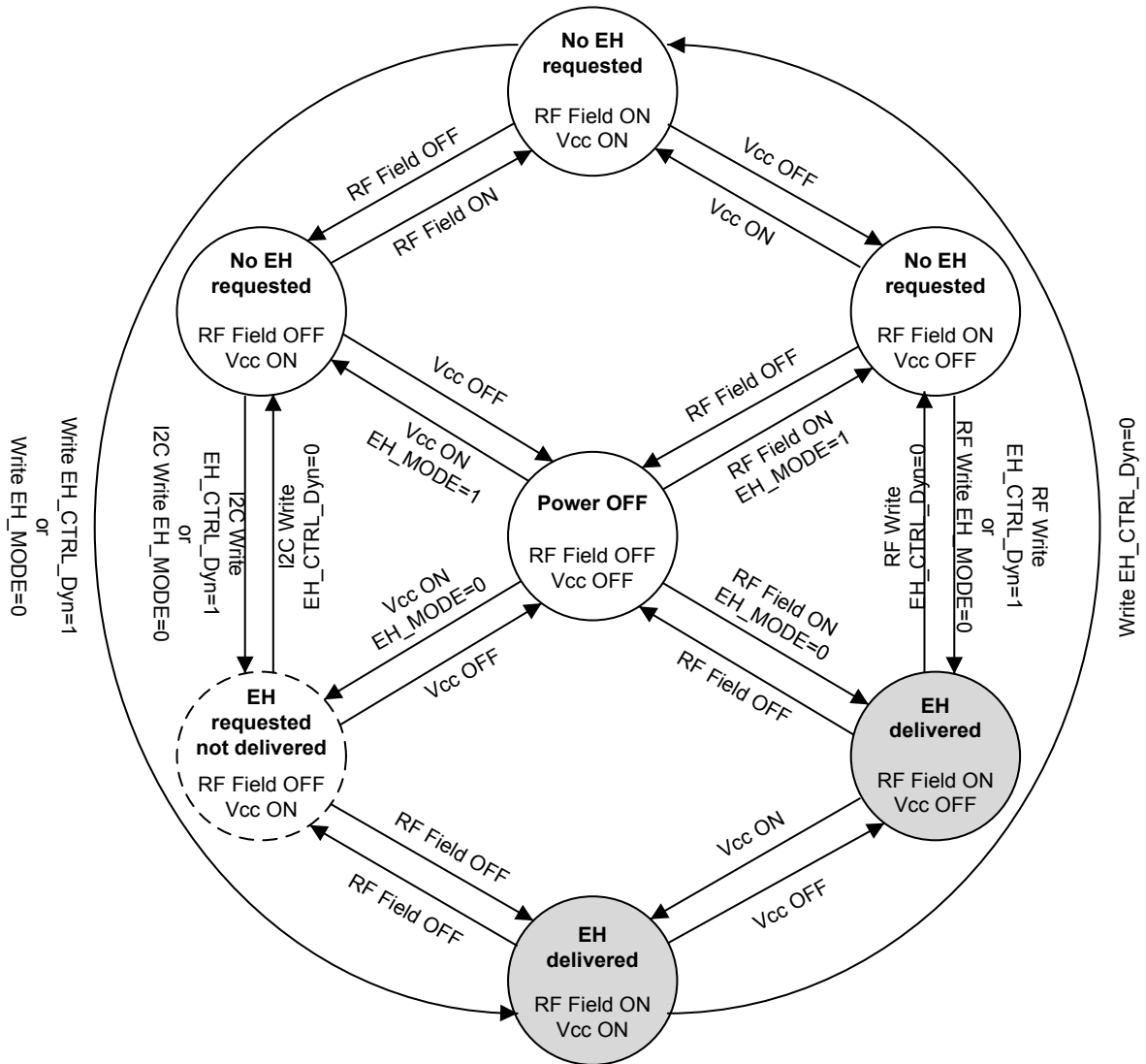
EH\_CTRL\_Dyn allows to activate or deactivate on the fly the Energy harvesting (EH\_EN) and bring information on actual state of EH and state of power supplies :

- EH\_ON set reflects the EH\_EN bit value
- FIELD\_ON is set in presence of an RF field
- VCC\_ON is set when Host power supply is on, and low power-down mode is not forced.

During boot, EH is not delivered to avoid alteration in device configuration.

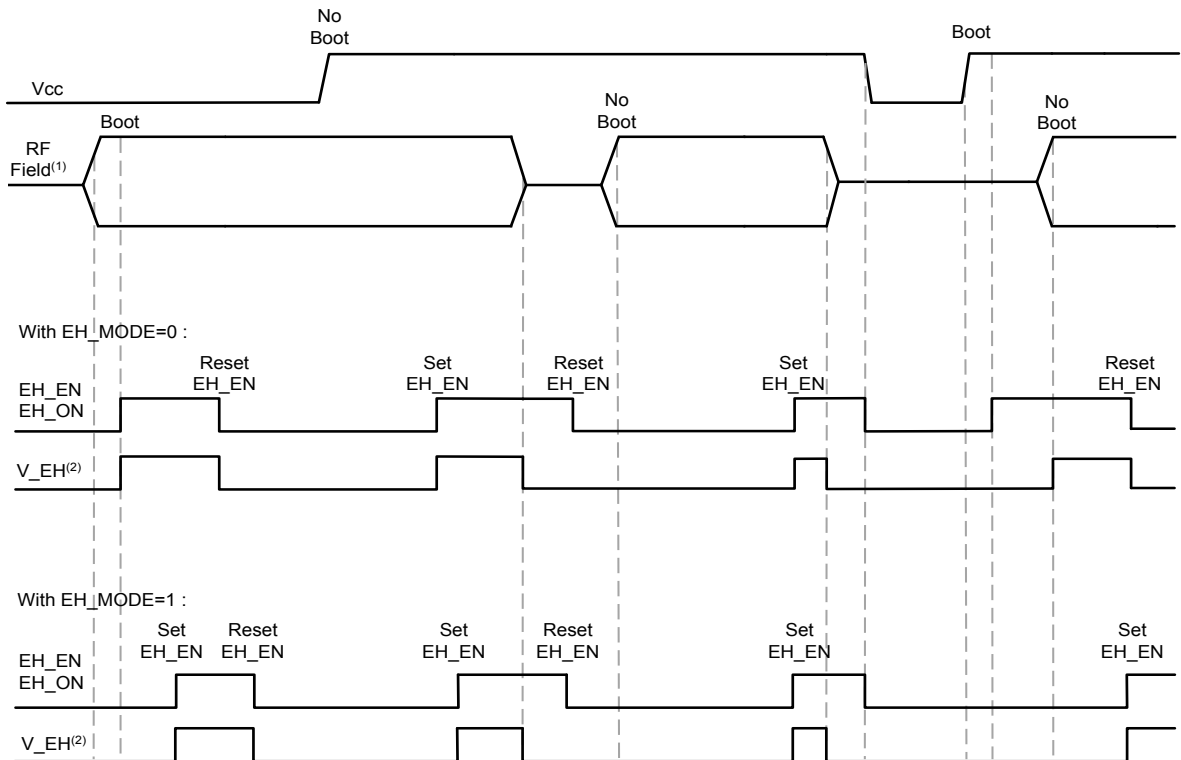
**Caution:** Communication is not guaranteed during EH delivery. Refer to the application note AN4913 (Energy harvesting delivery impact on ST25DVxxKC behaviour during RF communication).

Energy harvesting can be set even if ST25DVxxKC is in RF disabled or RF Sleep mode, or in Low power mode. In all these cases, ST25DVxxKC delivers power on V\_EH pin if RF field is present. Energy harvesting voltage output is not regulated.

**5.5.3 EH delivery state diagram**
**Figure 26. EH delivery state diagram**


**Note:** Power is delivered on V\_EH only if harvested energy is sufficient to supply ST25DVxxKC and leave over power. Grey color indicates the states where power is delivered on V\_EH pin.

### 5.5.4 EH delivery sequence

**Figure 27. ST25DVxxKC Energy Harvesting Delivery Sequence**


1. We suppose that the captured RF power is sufficient to trig EH delivery.
2. V\_EH = 1 means some  $\mu\text{W}$  are available on V\_EH pin.  
V\_EH = 0 means V\_EH pin is in high-Z.

## 5.6 Data protection

ST25DVxxKC 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, both from RF and I<sup>2</sup>C access.

### 5.6.1 Data protection registers

**Table 44. RFA1SS access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @04h	R always, W if RF configuration security session is open and configuration not locked	E2=1, E1=1, 0004h	R always, W if I <sup>2</sup> C security session is open
Write Configuration (cmd code A1h) @04h			

**Table 45. RFA1SS**

Bit	Name	Function	Factory value
b1-b0	PWD_CTRL_A1	00: Area 1 RF user security session can't be open by password 01: Area 1 RF user security session is open by RF_PWD_1 10: Area 1 RF user security session is open by RF_PWD_2 11: Area 1 RF user security session is open by RF_PWD_3	00b
b3-b2	RW_PROTECTION_A1	00: Area 1 RF access: Read always allowed / Write always allowed 01: Area 1 RF access: Read always allowed, Write allowed if RF user security session is open 10: Area 1 RF access: Read always allowed, Write allowed if RF user security session is open 11: Area 1 RF access: Read always allowed, Write always forbidden	00b
b7-b4	RFU	-	0000b

Note: Refer to Table 13. System configuration memory map for the RFA1SS register.

**Table 46. RFA2SS access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @06h Write Configuration (cmd code A1h) @06h	R always, W if RF configuration security session is open and configuration not locked	E2=1, E1=1, 0006h	R always, W if I <sup>2</sup> C security session is open

**Table 47. RFA2SS**

Bit	Name	Function	Factory value
b1-b0	PWD_CTRL_A2	00: Area 2 RF user security session can't be open by password 01: Area 2 RF user security session is open by RF_PWD_1 10: Area 2 RF user security session is open by RF_PWD_2 11: Area 2 RF user security session is open by RF_PWD_3	00b
b3-b2	RW_PROTECTION_A2	00: Area 2 RF access: Read always allowed, Write always allowed 01: Area 2 RF access: Read always allowed, Write allowed if RF user security session is open 10: Area 2 RF access: Read allowed if RF user security session is open, Write allowed if RF user security session is open 11: Area 2 RF access: Read allowed if RF user security session is open, Write always forbidden	00b

Note: Refer to Table 13. System configuration memory map for the RFA2SS register.

**Table 48. RFA3SS access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @08h Write Configuration (cmd code A1h) @08h	R always, W if RF configuration security session is open and configuration not locked	E2=1, E1=1, 0008h	R always, W if I <sup>2</sup> C security session is open

**Table 49. RFA3SS**

Bit	Name	Function	Factory value
b1-b0	PWD_CTRL_A3	00: Area 3 RF user security session can't be open by password 01: Area 3 RF user security session is open by RF_PWD_1 10: Area 3 RF user security session is open by RF_PWD_2 11: Area 3 RF user security session is open by RF_PWD_3	00b
b3-b2	RW_PROTECTION_A3	00: Area 3 RF access: Read always allowed / Write always allowed 01: Area 3 RF access: Read always allowed, Write allowed if RF user security session is open 10: Area 3 RF access: Read allowed if RF user security session is open, Write allowed if RF user security session is open 11: Area 3 RF access: Read allowed if RF user security session is open, Write always forbidden	00b
b7-b4	RFU	-	0000b

Note: Refer to [Table 13. System configuration memory map for the RFA3SS register.](#)

**Table 50. RFA4SS access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @0Ah Write Configuration (cmd code A1h) @0Ah	R always, W if RF configuration security session is open and configuration not locked	E2=1, E1=1, 000Ah	R always, W if I <sup>2</sup> C security session is open

**Table 51. RFA4SS**

Bit	Name	Function	Factory value
b1-b0	PWD_CTRL_A4	00: Area 4 RF user security session can't be open by password 01: Area 4 RF user security session is open by RF_PWD_1 10: Area 4 RF user security session is open by RF_PWD_2 11: Area 4 RF user security session is open by RF_PWD_3	00b
b3-b2	RW_PROTECTION_A4	00: Area 4 RF access: Read always allowed, Write always allowed 01: Area 4 RF access: Read always allowed, Write allowed if RF user security session is open 10: Area 4 RF access: Read allowed if RF user security session is open, Write allowed if RF user security session is open 11: Area 4 RF access: Read allowed if RF user security session is open, Write always forbidden	00b
b7-b4	RFU	-	0000b

Note: Refer to [Table 13. System configuration memory map for the RFA4SS register.](#)

**Table 52. I2CSS access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
No access		E2=1, E1=1, 000Bh	R always, W if I <sup>2</sup> C security session is open

**Table 53. I2CSS**

Bit	Name	Function	Factory value
b1-b0	RW_PROTECTION_A1	00: Area 1 I <sup>2</sup> C access: Read always allowed, Write always allowed 01: Area 1 I <sup>2</sup> C access: Read always allowed, Write allowed if I <sup>2</sup> C user security session is open 10: Area 1 I <sup>2</sup> C access: Read always allowed, Write always allowed 11: Area 1 I <sup>2</sup> C access: Read always allowed, Write allowed if I <sup>2</sup> C user security session is open	00b
b3-b2	RW_PROTECTION_A2	00: Area 2 I <sup>2</sup> C access: Read always allowed, Write always allowed 01: Area 2 I <sup>2</sup> C access: Read always allowed, Write allowed if I <sup>2</sup> C user security session is open 10: Area 2 I <sup>2</sup> C access: Read allowed if I <sup>2</sup> C user security session is open, Write always allowed 11: Area 2 I <sup>2</sup> C access: Read allowed if I <sup>2</sup> C security session is open, Write allowed if I <sup>2</sup> C security session is open	00b
b5-b4	RW_PROTECTION_A3	00: Area 3 I <sup>2</sup> C access: Read always allowed, Write always allowed 01: Area 3 I <sup>2</sup> C access: Read always allowed, Write allowed if I <sup>2</sup> C user security session is open 10: Area 3 I <sup>2</sup> C access: Read allowed if I <sup>2</sup> C user security session is open, Write always allowed 11: Area 3 I <sup>2</sup> C access: Read allowed if I <sup>2</sup> C security session is open, Write allowed if I <sup>2</sup> C security session is open	00b
b7-b6	RW_PROTECTION_A4	00: Area 4 I <sup>2</sup> C access: Read always allowed, Write always allowed 01: Area 4 I <sup>2</sup> C access: Read always allowed, Write allowed if I <sup>2</sup> C user security session is open 10: Area 4 I <sup>2</sup> C access: Read allowed if I <sup>2</sup> C user security session is open, Write always allowed 11: Area 4 I <sup>2</sup> C access: Read allowed if I <sup>2</sup> C security session is open, Write allowed if I <sup>2</sup> C security session is open	00b

**Note:** Refer to [Table 13. System configuration memory map for the I2CSS register.](#)

**Table 54. LOCK\_CCFILE access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Lock Block (cmd code 22h) @00h/01h <sup>(1)</sup> Ext Lock Block (cmd code 32h) @00h/01h Read Block (cmd code 20h) @00h/01h Fast Read Block <sup>(1)</sup> (cmd code C0h) @00h/01h Ext Read Block <sup>(1)</sup> (cmd code 30h) @00h/01h Fast Ext Read Block <sup>(1)</sup> (cmd code C4h) @00h/01h Read Multi Block <sup>(1)</sup> (cmd code 23h) @00h/01h Ext Read Multi Block <sup>(1)</sup> (cmd code 33h) @00h/01h Fast Read Multi Block <sup>(1)</sup> (cmd code C3h) @00h/01h Fast Ext Read Multi Block <sup>(1)</sup> (cmd code C5h) @00h/01h Get Multi Block SS (cmd code 2Ch) @00h/01h Ext Get Multi Block SS (cmd code 3Ch) @00h/01h	R always b0: W if Block 00h is not already locked, b1: W if Block 01h is not already locked.	E2=1, E1=1, 000Ch	R always, W if I <sup>2</sup> C security session is open

1. With option flag set to 1.

**Table 55. 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 13. System configuration memory map for the LOCK\_CCFILE register.

**Table 56. LOCK\_CFG access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Read Configuration (cmd code A0h) @0Fh Write Configuration (cmd code A1h) @0Fh	R always, W if RF configuration security session is open and configuration not locked	E2=1, E1=1, 000Fh	R always, W if I <sup>2</sup> C security session is open

**Table 57. 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 13. System configuration memory map for the LOCK\_CFG register.

**Table 58. I2C\_PWD access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
No access		E2=1, E1=1, 0900h to 0907h, Present/Write password command format.	R if I <sup>2</sup> C security session is open, W if I <sup>2</sup> C security session is open

**Table 59. I2C\_PWD**

I <sup>2</sup> C address	Bit	Name	Function	Factory value
0900h	b7-b0	I2C_PWD	Byte 7 (MSB) of password for I <sup>2</sup> C security session	00h
0901h	b7-b0		Byte 6 of password for I <sup>2</sup> C security session	00h
0902h	b7-b0		Byte 5 of password for I <sup>2</sup> C security session	00h
0903h	b7-b0		Byte 4 of password for I <sup>2</sup> C security session	00h
0904h	b7-b0		Byte 3 of password for I <sup>2</sup> C security session	00h
0905h	b7-b0		Byte 2 of password for I <sup>2</sup> C security session	00h
0906h	b7-b0		Byte 1 of password for I <sup>2</sup> C security session	00h
0907h	b7-b0		Byte 0 (LSB) of password for I <sup>2</sup> C security session	00h

Note: Refer to [Table 13. System configuration memory map](#) for the I2C\_PWD register.

**Table 60. RF\_PWD\_0 access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Present Password (cmd code B3h) Write Password (cmd code B1h)	WO if RF configuration security session is open		No access

**Table 61. RF\_PWD\_0**

Bit	Name	Function	Factory value
b7-b0	RF_PWD_0	Byte 0 (LSB) of password for RF configuration security session	00h
		Byte 1 of password for RF configuration security session	00h
		Byte 2 of password for RF configuration security session	00h
		Byte 3 of password for RF configuration security session	00h
		Byte 4 of password for RF configuration security session	00h
		Byte 5 of password for RF configuration security session	00h
		Byte 6 of password for RF configuration security session	00h
		Byte 7 (MSB) of password for RF configuration security session	00h

Note: Refer to [Table 13. System configuration memory map](#) for the RF\_PWD\_0 register.



**Table 62. RF\_PWD\_1 access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Present Password (cmd code B3h) Write Password (cmd code B1h)	WO if RF configuration security session is open with RF password 1	No access	

**Table 63. RF\_PWD\_1**

Bit	Name	Function	Factory value
b7-b0	RF_PWD_1	Byte 0 (LSB) of password 1 for RF user security session	00h
		Byte 1 of password 1 for RF user security session	00h
		Byte 2 of password 1 for RF user security session	00h
		Byte 3 of password 1 for RF user security session	00h
		Byte 4 of password 1 for RF user security session	00h
		Byte 5 of password 1 for RF user security session	00h
		Byte 6 of password 1 for RF user security session	00h
		Byte 7 (MSB) of password 1 for RF user security session	00h

Note: Refer to [Table 13. System configuration memory map](#) for the RF\_PWD\_1 register.

**Table 64. RF\_PWD\_2 access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Present Password (cmd code B3h) Write Password (cmd code B1h)	WO if RF user security session is open with RF password 2	No access	

**Table 65. RF\_PWD\_2**

Bit	Name	Function	Factory value
b7-b0	RF_PWD_2	Byte 0 (LSB) of password 2 for RF user security session	00h
		Byte 1 of password 2 for RF user security session	00h
		Byte 2 of password 2 for RF user security session	00h
		Byte 3 of password 2 for RF user security session	00h
		Byte 4 of password 2 for RF user security session	00h
		Byte 5 of password 2 for RF user security session	00h
		Byte 6 of password 2 for RF user security session	00h
		Byte 7 (MSB) of password 2 for RF user security session	00h

Note: Refer to [Table 13. System configuration memory map](#) for the RF\_PWD\_2 register.

**Table 66. RF\_PWD\_3 access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Present Password (cmd code B3h) Write Password (cmd code B1h)	WO if RF user security session is open with RF password 3	No access	

**Table 67. RF\_PWD\_3**

Bit	Name	Function	Factory value
b7-b0	RF_PWD_3	Byte 0 (LSB) of password 3 for RF user security session	00h
		Byte 1 of password 3 for RF user security session	00h
		Byte 2 of password 3 for RF user security session	00h
		Byte 3 of password 3 for RF user security session	00h
		Byte 4 of password 3 for RF user security session	00h
		Byte 5 of password 3 for RF user security session	00h
		Byte 6 of password 3 for RF user security session	00h
		Byte 7 (MSB) of password 3 for RF user security session	00h

Note: Refer to [Table 13. System configuration memory map](#) for the RF\_PWD\_3 register.

**Table 68. I2C\_SSO\_Dyn access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
No access		E2=0, E1=1, 2004h	RO

**Table 69. I2C\_SSO\_Dyn**

Bit	Name	Function	Factory value
b7-b1	RFU	-	0b
b0	I2C_SSO	0: I <sup>2</sup> C security session close 1: I <sup>2</sup> C security session open (Set or reset via I <sup>2</sup> C Present password command)	0b

Note: Refer to [Table 13. System configuration memory map](#) for the I2C\_SSO\_Dyn register.

### 5.6.2 Passwords and security sessions

ST25DVxxKC provides protection of user memory and system configuration static registers. RF user and I<sup>2</sup>C host can access those protected data by opening security sessions with the help of passwords. Access rights is more restricted when security sessions are closed, and less restricted when security sessions are open.

Dynamic registers and fast transfer mode mailbox are not protected by any security session.

There is three type of security sessions, as shown in the table below:

**Table 70. Security session type**

Security session	Open by presenting	Right granted when security session is open, and until it is closed
RF user	RF password 1, 2 or 3 <sup>(1)</sup> (RF_PWD_1, RF_PWD_2, RF_PWD_3)	RF user access to protected user memory as defined in RFA <sub>i</sub> SS registers RF user write access to RF password 1, 2 or 3 <sup>(2)</sup>
RF configuration	RF password 0 (RF_PWD_0)	RF user write access to configuration static registers RF user write access to RF password 0
I <sup>2</sup> C	I <sup>2</sup> C password (I2C_PWD)	I <sup>2</sup> C host access to protected user memory as defined in I2CSS register I <sup>2</sup> C host write access to configuration static registers I <sup>2</sup> C host write access to I <sup>2</sup> C password

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-bit long, and default factory passwords value is 0000000000000000h.

The ST25DVxxKC passwords management is organized around RF and I<sup>2</sup>C dedicated set of commands to access the dedicated registers in system configuration area where password values are stored.

The dedicated password commands in RF mode are:

- Write Password command (code B1h): see [Section 7.6.36 Present Password](#).
- Present Password command (code B3h): see [Section 7.6.36 Present Password](#).

RF user possible actions for security sessions are:

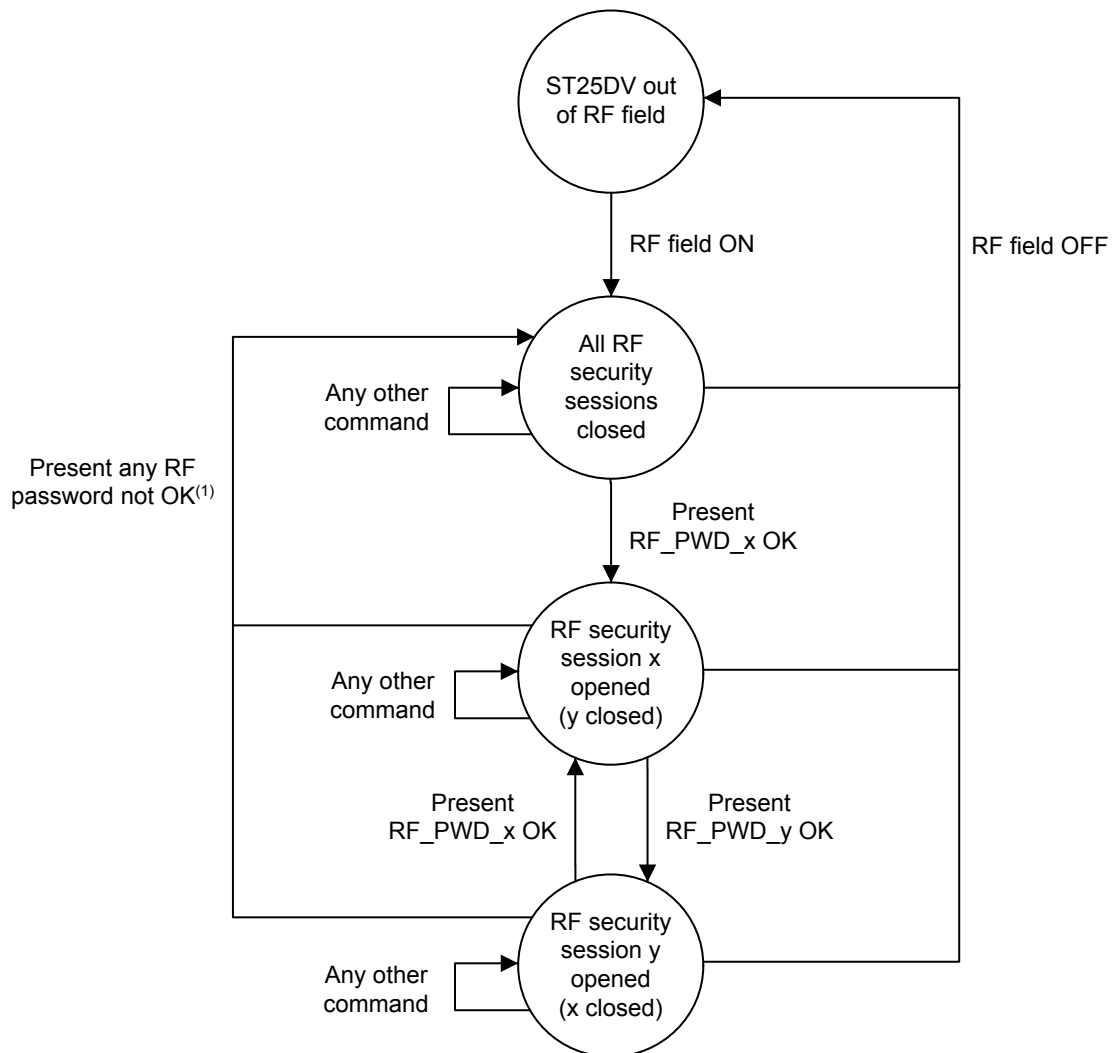
- **Open RF user security session:** Present Password command, with password number 1, 2 or 3 and the valid corresponding password
- **Write RF password:** Present Password command, with password number (0, 1, 2 or 3) and the current valid corresponding password. Then Write Password command, with same password number (0, 1, 2 or 3) and the new corresponding password.
- **Close RF 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 RF configuration security session:** Present Password command, with password number 0 and the valid password 0.
- **Close RF 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 RF field (POR). Presenting a password with an invalid password number doesn't close the session.

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

There is no interaction between I<sup>2</sup>C and RF security sessions. Both are independent, and can run in parallel.

**Caution:** If ST25DVxxKC is powered through V<sub>CC</sub>, removing V<sub>CC</sub> during an RF command can abort the command. As a consequence, before writing a new password, RF user should check if V<sub>CC</sub> is ON, by reading EH\_CTRL\_Dyn register bit 3 (VCC\_ON), and eventually ask host to maintain or to shut down V<sub>CC</sub>, before issuing the Write Password command in order to avoid password corruption.

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 28. RF security sessions management**


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

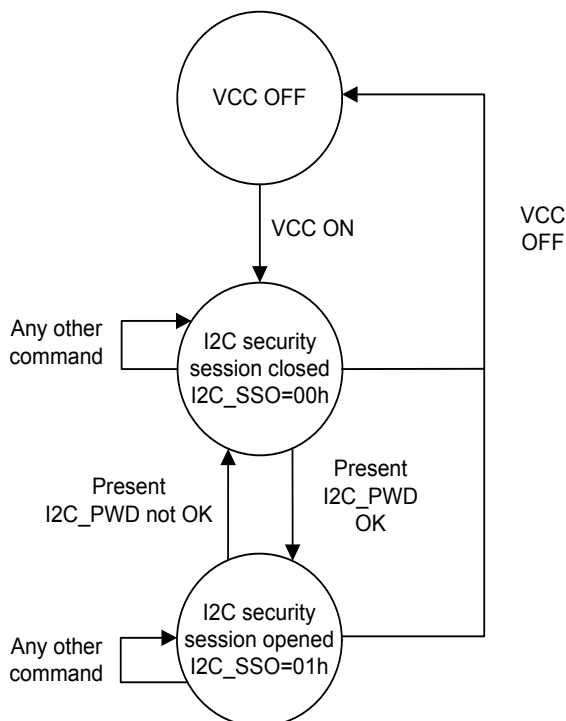
The dedicated password commands in I<sup>2</sup>C mode are:

- I<sup>2</sup>C Write Password command: see [Section 6.6.2 I<sup>2</sup>C write password command description](#).
- I<sup>2</sup>C Present Password command: see [Section 6.6.1 I<sup>2</sup>C present password command description](#).

I<sup>2</sup>C host possible actions for security sessions are:

- **Open I<sup>2</sup>C security session:** I<sup>2</sup>C Present Password command with valid I<sup>2</sup>C password.
- **Write I<sup>2</sup>C password:** I<sup>2</sup>C Present Password command with valid I<sup>2</sup>C password. Then I<sup>2</sup>C Write Password command with new I<sup>2</sup>C password.
- **Close I<sup>2</sup>C security session:** I<sup>2</sup>C Present Password command with wrong I<sup>2</sup>C password. Or remove tag V<sub>CC</sub> power supply (POR).
- **Check if I<sup>2</sup>C security session is open:** I<sup>2</sup>C host can read the current status (open or closed) of I<sup>2</sup>C security session by reading the I2C\_SSO\_Dyn register.

There is no interaction between I<sup>2</sup>C and RF security sessions. Both are independent and can run in parallel.

**Figure 29. I<sup>2</sup>C security sessions management**


### 5.6.3 User memory protection

On factory delivery, areas are not protected.

Each area can be individually protected in read and/or write access from RF and I<sup>2</sup>C.

Area 1 is always readable (from RF and I<sup>2</sup>C).

Furthermore, RF blocks 0 and 1 (I<sup>2</sup>C bytes 0000h to 0007h) can be independently write locked.

#### User memory protection from RF access

In RF mode, each memory area of the ST25DVxxKC can be individually protected by one out of three available passwords (RF password 1, 2 or 3), and each area can also have individual Read/Write access conditions.

For each area, an RFA<sub>i</sub>SS register is used to:

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

(See Table 45. RFA1SS, Table 47. RFA2SS, Table 49. RFA3SS, and Table 51. RFA4SS for details about available read and write protections).

*Note:* Setting 00b in PWD\_CTRL\_A<sub>i</sub> field means that RF user security session cannot be open by any password for the corresponding area.

When updating RFA<sub>i</sub>SS registers, the new protection value is effective immediately after the register write completion.

- Rf blocks 0 and 1 are exceptions to this protection mechanism:
  - RF blocks 0 and 1 can be individually write locked by issuing a (Ext) Lock Single Block RF command. Once locked, they cannot be unlock through RF. LOCK\_CCFILE register is automatically updated when using (Ext) Lock Single Block command.
  - An RF 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 RFA1SS register) does not unlock blocks 0 and 1 if they have been locked though (Ext) Lock Block command.
  - Once locked, the RF user cannot unlock blocks 0 and/or 1 (can be done by I<sup>2</sup>C host).

*Note:* When areas size are modified (ENDAI registers), RFAiSS registers are not modified.

### User memory protection from I<sup>2</sup>C access

In I<sup>2</sup>C mode, each area can also have individual Read/Write access conditions, but only one I<sup>2</sup>C password is used to unlock I<sup>2</sup>C security session for all areas.

The I2CSS register is used to set protection against read and write operation for each area (see Table 53. I2CSS for details about available read and write protections).

When updating I2CSS registers, the new protection value is effective immediately after the register write completion.

I<sup>2</sup>C user memory Bytes 0000h to 0003h (RF Block 0) and 0004h to 0007h (RF Block 1) can be individually locked and unlocked by writing in the LOCK\_CCFILE register (by group of 4 Bytes), independently of Area 1 protection. Unlocking Area 1 (through I2CSS register) does not unlock those bytes if they have been locked though the LOCK\_CCFILE register.

*Note:* When areas size are modified (ENDAI registers), I2CSS register is not modified.

### Retrieve the security status of a user memory block or byte

RF user can read a block security status by issuing following RF 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.

ST25DV responds with a Block security status containing a Lock\_bit flag as specified in ISO 15693 standard. This lock\_bit flag is set to one if block is locked against write.

Lock\_bit flag value may vary if corresponding RF user security session is open or closed.

I<sup>2</sup>C host can retrieve a block security status by reading the I2CSS register to get security status of the corresponding area and by reading the I2C\_SSO\_Dyn register to know if I<sup>2</sup>C security session is open or closed.

For blocks 0 and 1 (Bytes 0000h to 0007h in I<sup>2</sup>C user memory), lock status can also be read in the LOCK\_CCFILE register.

## 5.6.4 System memory protection

By default, system memory (static registers) is write protected, both in RF and I<sup>2</sup>C.

I<sup>2</sup>C host must open the I<sup>2</sup>C security session (by presenting a valid I<sup>2</sup>C password) to enable write access to system configuration static registers.

I<sup>2</sup>C host doesn't have read or write access to RF passwords.

By default, I<sup>2</sup>C host can read all system configuration static registers (except RF passwords)

In RF, to enable write access to system configuration static registers, RF user must open the RF configuration security session (by presenting a valid RF password 0) and system configuration must not be locked (LOCK\_CFG=00h).

RF doesn't have read or write access to I<sup>2</sup>C password.

By default, RF user can read all system configuration static registers, except all passwords, LOCK\_CCFILE, LOCK\_DSFID and LOCK\_AFI.

RF configuration lock:

- RF write access to system configuration static registers can be locked by writing 01h in the LOCK\_CFG register (by RF or I<sup>2</sup>C).
- RF user cannot unlock system configuration if LOCK\_CFG=01h, even after opening RF configuration security session (only I<sup>2</sup>C host can unlock system configuration).
- When system configuration is locked (LOCK\_CFG=01h), it is still possible to change RF passwords (0 to 3).

Device identification registers:

- AFI and DFSID registers can be independently locked by RF 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 I<sup>2</sup>C). 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, IC\_REV) are read only registers for both RF and I<sup>2</sup>C.

## 5.7 Device parameter registers

**Table 71. LOCK\_DSFID access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Lock DSFID (cmd code 2Ah)	WO if DSFID not locked	E2=1, E1=1, 0010h	RO

**Table 72. 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 13. System configuration memory map](#) for the LOCK\_DSFID register.

**Table 73. LOCK\_AFI access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Lock AFI (cmd code 28h)	WO if AFI not locked	E2=1, E1=1, 0011h	RO

**Table 74. 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 13. System configuration memory map](#) for the LOCK\_AFI register.

**Table 75. DSFID access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Inventory (cmd code 01h) Get System Info (cmd code 2Bh) Ext Get System Info (cmd code 3Bh) Write DSFID (cmd code 28h)	R always, W if DSFID not locked	E2=1, E1=1, 0012h	RO

**Table 76. DSFID**

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

Note: Refer to [Table 13. System configuration memory map](#) for the DSFID register.

**Table 77. AFI access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Inventory (cmd code 01h) Get System Info (cmd code 2Bh) Ext Get System Info (cmd code 3Bh) Write AFI (cmd code 27h)	R always, W if AFI not locked	E2=1, E1=1, 0013h	RO

**Table 78. AFI**

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

Note: Refer to [Table 13. System configuration memory map](#) for the AFI register.

**Table 79. MEM\_SIZE access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Get System Info (cmd code 2Bh) <sup>(1)</sup> Ext Get System Info (cmd code 3Bh)	RO	E2=1, E1=1, 0014h to 0015h	RO

1. Only ST25DV04KC



**Table 80. MEM\_SIZE**

I <sup>2</sup> C Address	Bit	Name	Function	Factory value
0014h	b7-b0	MEM_SIZE	Address 0014h: LSB byte of the memory size expressed in RF blocks	ST25DV04KC: 7Fh ST25DV16KC: FFh ST25DV64KC: FFh
0015h	b7-b0		Address 0015h: MSB byte of the memory size expressed in RF blocks	ST25DV04KC: 00h ST25DV16KC: 01h ST25DV64KC: 07h

Note: Refer to [Table 13. System configuration memory map](#) for the MEM\_SIZE register.

**Table 81. BLK\_SIZE access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Get System Info (cmd code 2Bh) <sup>(1)</sup> Ext Get System Info (cmd code 3Bh)	RO	E2=1, E1=1, 0016h	RO

1. Only ST25DV04KC

**Table 82. BLK\_SIZE**

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

Note: Refer to [Table 13. System configuration memory map](#) for the BLK\_SIZE register.

**Table 83. IC\_REF access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Get System Info (cmd code 2Bh) Ext Get System Info (cmd code 3Bh)	RO	E2=1, E1=1, 0017h	RO

**Table 84. IC\_REF**

Bit	Name	Function	Factory value
b7-b0	IC_REF	ISO/IEC 15693 IC Reference	ST25DV04KC-IE: 50h ST25DV16KC-IE: 51h ST25DV64KC-IE: 51h ST25DV04KC-JF: 50h ST25DV16KC-JF: 51h ST25DV64KC-JF: 51h

Note: Refer to [Table 13. System configuration memory map](#) for the IC\_REF register.

**Table 85. UID access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
Inventory (cmd code 01h) Get System Info (cmd code 2Bh) Ext Get System Info (cmd code 3Bh)	RO	E2=1, E1=1, 0018h to 001Fh	RO

**Table 86. UID**

I <sup>2</sup> C Address	Bit	Name	Function	Factory <sup>2</sup> alue
0018h	b7-b0	UID	ISO/IEC 15693 UID byte 0 (LSB)	IC manufacturer serial number
0019h			ISO/IEC 15693 UID byte 1	
001Ah			ISO/IEC 15693 UID byte 2	
001Bh			ISO/IEC 15693 UID byte 3	
001Ch			ISO/IEC 15693 UID byte 4	
001Dh			ISO/IEC 15693 UID byte 5: ST Product code	ST25DV04KC-IE: 50h ST25DV16KC-IE: 51h ST25DV64KC-IE: 51h ST25DV04KC-JF: 52h ST25DV16KC-JF: 53h ST25DV64KC-JF: 53h
001Eh			ISO/IEC 15693 UID byte 6: IC Mfg code	02h
001Fh	ISO/IEC 15693 UID byte 7 (MSB)	E0h		

Note: Refer to [Table 13. System configuration memory map for the UID register.](#)

**Table 87. IC\_REV access**

RF		I <sup>2</sup> C	
Command	Type	Address	Type
No access		E2=1, E1=1, 0020h	RO

**Table 88. IC\_REV**

Bit	Name	Function	Factory value
b7-b0	IC_REV	IC revision	Depending on revision

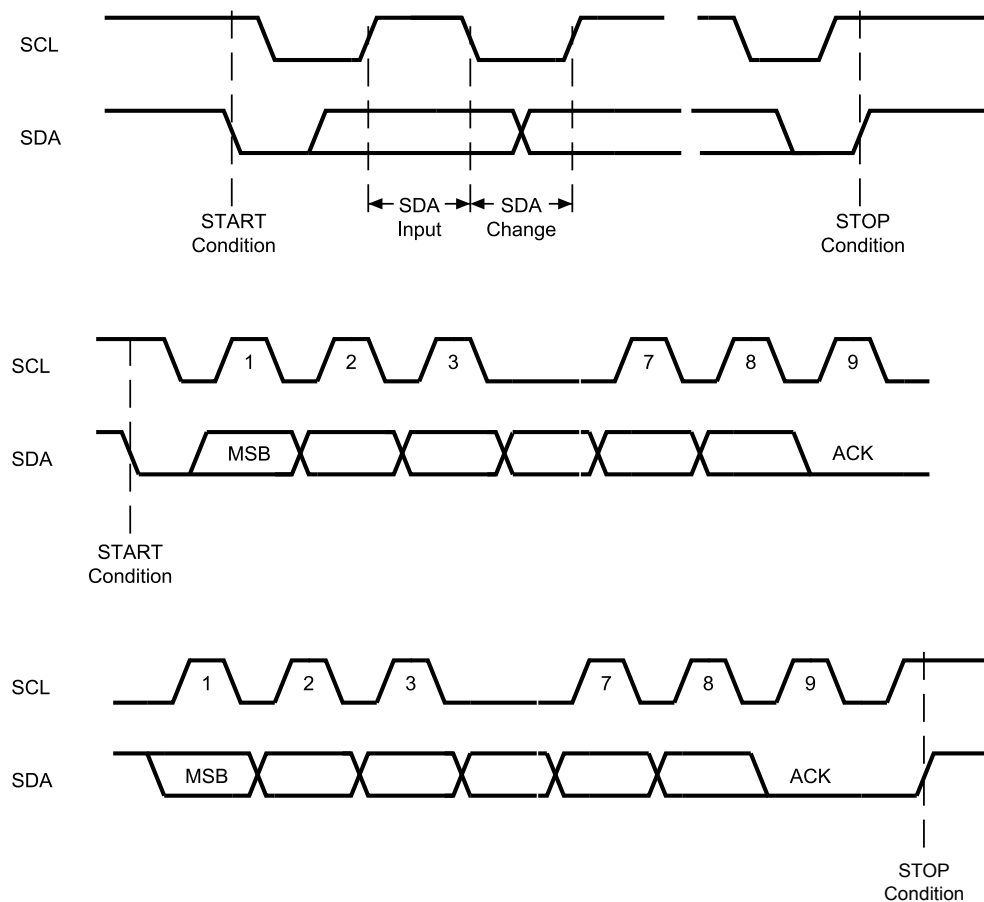
Note: Refer to [Table 13. System configuration memory map for the IC\\_REV register.](#)

## 6 I<sup>2</sup>C operation

### 6.1 I<sup>2</sup>C protocol

The device supports the I<sup>2</sup>C protocol. This is summarized in Figure 30. I<sup>2</sup>C bus protocol. Any device that sends data to the bus is defined as a transmitter, and any device that reads data is defined as a receiver. The device that controls the data transfer is known as the bus master, and the other as the slave device. A data transfer can only be initiated by the bus master, which also provides the serial clock for synchronization. The ST25DVxxKC device is a slave in all communications.

Figure 30. I<sup>2</sup>C bus protocol



#### 6.1.1 Start condition

Start is identified by a falling edge of serial data (SDA) while the serial clock (SCL) is stable in the high state. A Start condition must precede any data transfer command. The device continuously monitors (except during a write cycle) the SDA and the SCL for a Start condition, and does not respond unless one is given.

### 6.1.2 Stop condition

Stop is identified by a rising edge of serial data (SDA) while the serial clock (SCL) is stable and driven high. A Stop condition terminates communication between the device and the bus master. A Read command that is followed by NoAck can be followed by a Stop condition to force the device into the Standby mode. A Stop condition at the end of a Write command triggers the internal write cycle.

### 6.1.3 Acknowledge bit (ACK)

The acknowledge bit is used to indicate a successful byte transfer. The bus transmitter, whether a bus master or a slave device, releases the serial data (SDA) after sending eight bits of data. During the 9<sup>th</sup> clock pulse period, the receiver pulls the SDA low to acknowledge the receipt of the eight data bits.

### 6.1.4 Data input

During data input, the device samples serial data (SDA) on the rising edge of the serial clock (SCL). For correct device operation, the SDA must be stable during the rising edge of the SCL, and the SDA signal must change only when the SCL is driven low.

## 6.2 I<sup>2</sup>C timeout

During the execution of an I<sup>2</sup>C operation, RF communications are not possible.

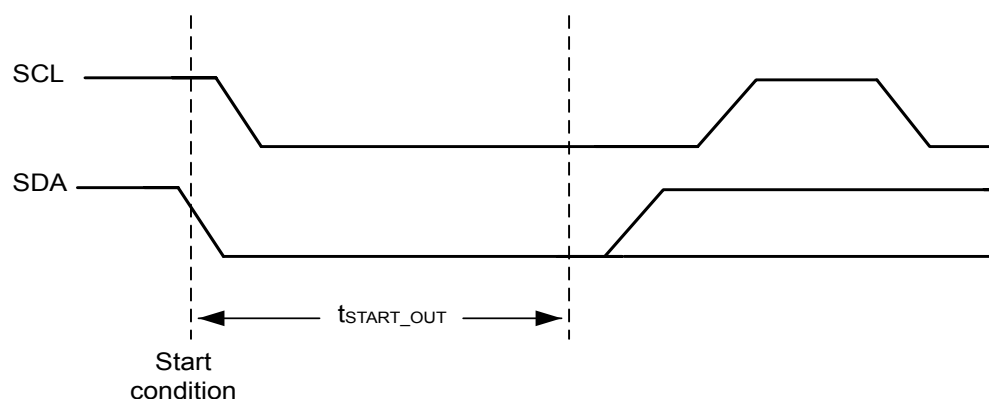
To prevent RF communication freezing due to inadvertent indeterminate instructions sent to the I<sup>2</sup>C bus, the ST25DVxxKC features a timeout mechanism that automatically resets the I<sup>2</sup>C logic block.

### 6.2.1 I<sup>2</sup>C timeout on Start condition

I<sup>2</sup>C communication with the ST25DVxxx starts with a valid Start condition, followed by a device select code.

If the delay between the Start condition and the following rising edge of the serial clock (SCL) that samples the most significant of the device select exceeds the  $t_{\text{START\_OUT}}$  time (see [Table 249. I<sup>2</sup>C DC characteristics up to 85 °C](#) and [Table 250. I<sup>2</sup>C DC characteristics up to 125 °C](#)), the I<sup>2</sup>C logic block is reset and further incoming data transfer is ignored until the next valid Start condition.

**Figure 31. I<sup>2</sup>C timeout on Start condition**



### 6.2.2 I<sup>2</sup>C timeout on clock period

During data transfer on the I<sup>2</sup>C bus, if the serial clock pulse width high ( $t_{\text{CHCL}}$ ) or serial clock pulse width low ( $t_{\text{CLCH}}$ ) exceeds the maximum value specified in [Table 251. I<sup>2</sup>C AC characteristics up to 85 °C](#) and [Table 252. I<sup>2</sup>C AC characteristics up to 125 °C](#), the I<sup>2</sup>C logic block is reset and any further incoming data transfer is ignored until the next valid Start condition.

### 6.3 Device addressing

To start a communication between the bus master and the slave device, the bus master must initiate a Start condition. Following this, the bus master sends the device select code, shown in [Section B.1 Device select codes](#) (on serial data (SDA), the most significant bit first).

The device select code consists of a 4-bit device type identifier (I2C\_DEVICE\_CODE) and a 3-bit Chip Enable "Address" (E2, E1, E0). Chip Enable bits E2 and E1 are used to select ST25DVxxKC memory to address (user or system) and to send special I2C "RFSwitchOff" and I2C "RFSwitchOn" commands.

The eighth bit is the Read/Write bit (RW). It is set to 1 for Read and to 0 for Write operations. Refer to the table below.

**Table 89. Device select code**

ST25DVxxKC function	I2C device type identifier				E2	E1	E0	R/notW
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
User memory	I2C_DEVICE_CODE[3:0]				0	1	I2C_E0	1/0
System memory					1	1		1/0
I2C RFSwitchOff					0	0		0
I2C RFSwitchOn					1	0		0

The 4-bit device type identifier and the Chip Enable bit E0 are configurable through the I2C\_CFG static register.

**Table 90. I2C\_CFG access**

RF		I2C	
Command	Type	Address	Type
No access		E2=1, E1=1, 000Eh	R always, W if I2C security session is open

**Table 91. I2C\_CFG**

Bit	Name	Function	Factory value
b3-b0	I2C_DEVICE_CODE	Device code (bits [7:4]) of I2C slave address	1010b
b4	I2C_E0	E0 bit (bit 1) of I2C slave address	1b
b5	I2C_RF_SWITCHOFF_EN	0: I2C cannot switch off/on RF with I2C « RFSwitchOff/On » commands. 1: I2C can switch off/on RF with I2C « RFSwitchOff/On » commands	0b
b7-b6	RFU	-	00b

*Note:* Refer to [Table 13. System configuration memory map for the UID register](#).

Change in I2C\_CFG command is immediate after STOP condition of the I2C write to this register. Next I2C accesses shall use the new value of I2C\_DEVICE\_CODE and I2C\_E0 to address the ST25DVxxKC.

If a match occurs on the device select code, the corresponding device gives an acknowledgement on serial data (SDA) during the ninth bit time. If the device does not match the device select code, it deselects itself from the bus, and goes into Standby mode.

**Table 92. Operating modes**

Mode	R $\overline{W}$ bit	Bytes	Initial sequence
Current address read	1	1	Start, device select, R $\overline{W}$ = 1
Random address read	0	1	Start, device select, R $\overline{W}$ = 0, address
	1		reStart, device select, R $\overline{W}$ = 1
Sequential read	1	≥ 1	Similar to current or random address read
Byte write	0	1	Start, device select, R $\overline{W}$ = 0
Sequential write	0	≤ 256 byte	Start, device select, R $\overline{W}$ = 0

## 6.4 I<sup>2</sup>C Write operations

Following a Start condition, the bus master sends a device select code with the Read/Write bit (R $\overline{W}$ ) reset to 0. The device acknowledges this, and waits for two address bytes. The device responds to each address byte with an acknowledge bit, and then waits for the data byte.

Each data byte in the memory has a 16-bit (two-byte wide) address. The most significant byte (see [Table 93. Address most significant byte](#)) is sent first, followed by the least significant byte (see [Table 94. Address least significant byte](#)). Bits b15 to b0 form the address of the byte in memory.

**Table 93. Address most significant byte**

b15	b14	b13	b12	b11	b10	b9	b8
-----	-----	-----	-----	-----	-----	----	----

**Table 94. Address least significant byte**

b7	b6	b5	b4	b3	b2	b1	b0
----	----	----	----	----	----	----	----

When the bus master generates a Stop condition immediately after the Ack bit (in the tenth-bit time slot), either at the end of a byte write or a sequential write, the internal write cycle is triggered. A Stop condition at any other time slot does not trigger the internal write cycle.

After the Stop condition, the delay  $t_W$ , and the successful completion of a Write operation, the device's internal address counter is incremented automatically, to point to the next byte address after the last one that was modified.

After an unsuccessful write operation, ST25DVxxKC enters in I<sup>2</sup>C dead state: internal address counter is not incremented, and is waiting for a full new I<sup>2</sup>C instruction (address counter stops to be incremented after the first NoAck bit).

During the internal write cycle, the serial data (SDA) signal is disabled internally, and the device does not respond to any requests.

**Caution:** I<sup>2</sup>C Writing data in user memory (EEPROM), transit via the 256 bytes fast transfer mode's buffer. Consequently fast transfer mode must be deactivated before starting any write operation in user memory, otherwise the command is NotACK, the programming is not done and device goes in standby mode.

### 6.4.1 I<sup>2</sup>C Byte write

After the device select code and the address bytes, the bus master sends one data byte.

If byte write is not inhibited, the device replies with Ack.

If byte write is inhibited, the device replies with NoAck.

The bus master terminates the transfer by generating a Stop condition (see [Figure 32. Write mode sequences when write is not inhibited](#)).

For byte write in EEPROM (user memory or system configuration), internal programming starts after the STOP condition, for a duration of  $t_W$  (as defined in [Table 249. I<sup>2</sup>C DC characteristics up to 85 °C](#) and [Table 250. I<sup>2</sup>C DC characteristics up to 125 °C](#)).

For writes in fast transfer mode buffer or Dynamic registers, internal programming is immediate at STOP condition.

If byte write is inhibited, the device replies with NoAck. The bus master terminates the transfer by generating a Stop condition and byte location not is modified (see [Figure 33. Write mode sequences when write is inhibited](#)).

Byte write is inhibited if byte complies with one of the following conditions:

- Byte is in user memory and is write protected with LOCK\_CCFILE register.
- Byte is in user memory and is write protected with I2CSS register, and I<sup>2</sup>C security session is closed.
- Byte is in user memory and fast transfer mode is activated.
- Byte is in system memory and is a Read Only register.
- Byte is in system memory and I<sup>2</sup>C security session is closed.
- Byte is in fast transfer mode's mailbox and is not the first Byte of mailbox.
- Byte is in fast transfer mode's mailbox and mailbox is busy.
- Byte is in fast transfer mode's mailbox and fast transfer mode is not activated.
- Byte is in dynamic registers area and is a Read Only register.

### 6.4.2 I<sup>2</sup>C Sequential write

The I<sup>2</sup>C sequential write allows up to 256 bytes to be written in one command, provided they are all located in the same user memory area and are all located in writable addresses.

After each byte is transferred, the internal byte address counter is incremented.

For each byte sent by the bus master:

- If byte write is not inhibited, the device replies with Ack.
- If byte write is inhibited, the device replies with NoAck.

The transfer is terminated by the bus master generating a Stop condition:

- For writes in EEPROM (user memory or system configuration), if all bytes have been Ack'ed, internal programming of all bytes starts after the stop condition, for a duration dependent on the number of bytes to write (see below).
- For writes in fast transfer mode buffer or Dynamic registers, if all bytes have been Ack'ed, internal programming is done immediately after the stop condition.
- If some bytes have been NotAck'ed, no internal programming is done (0 byte written).

Byte write is inhibited if byte complies with conditions described in [Section 6.4.1 I<sup>2</sup>C Byte write](#), in addition:

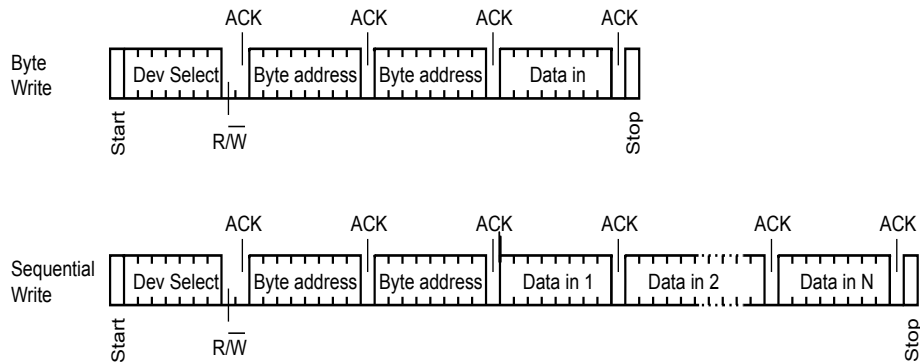
- Byte is in user memory but does not belong to same area than previous received byte (area border crossing is forbidden).
- 256 write occurrence have already been reached in the same sequential write.
- More than one byte is trying to be written in system area.

Seen from I<sup>2</sup>C, user memory is internally organized as rows of 16 bytes. Data located in the same row all share the same most significant memory address bits b16-b4.

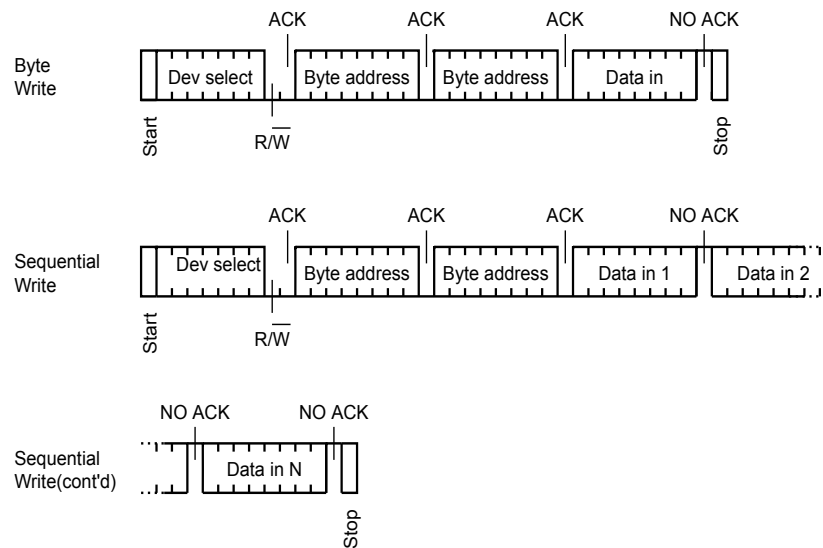
I<sup>2</sup>C sequential write programming time in the EEPROM memory is dependent on this internal organization: total programming time is the I<sup>2</sup>C write time  $t_W$  (as defined in [Table 249. I<sup>2</sup>C DC characteristics up to 85 °C](#) and [Table 250. I<sup>2</sup>C DC characteristics up to 125 °C](#)) multiplied by the number of internal EEPROM pages where the data must be programmed, including incomplete pages.

This means an I<sup>2</sup>C sequential write allows from 1 up to 16 bytes to be programmed in EEPROM in  $t_W$ , provided that they all share the same most significant memory address bits b16-b4.

For example, a successful I<sup>2</sup>C sequential write of 40 Bytes, starting at address 0010h, has a programming time (starting after STOP condition) of  $3 \times t_W$ . An I<sup>2</sup>C sequential write of 40 Bytes, starting at address 0008h, has a programming time of  $4 \times t_W$ .

**Figure 32. Write mode sequences when write is not inhibited**


Note:  $N \leq 256$

**Figure 33. Write mode sequences when write is inhibited**


Note:  $N \leq 256$

### 6.4.3 Minimizing system delays by polling on ACK

During the internal write cycle, the device disconnects itself from the bus, and writes a copy of the data from its internal latches to the memory cells. The maximum I<sup>2</sup>C write time ( $t_w$ ) is shown in [Table 251. I<sup>2</sup>C AC characteristics up to 85 °C](#) and [Table 252. I<sup>2</sup>C AC characteristics up to 125 °C](#), but the typical time is shorter. To make use of this, a polling sequence can be used by the bus master.

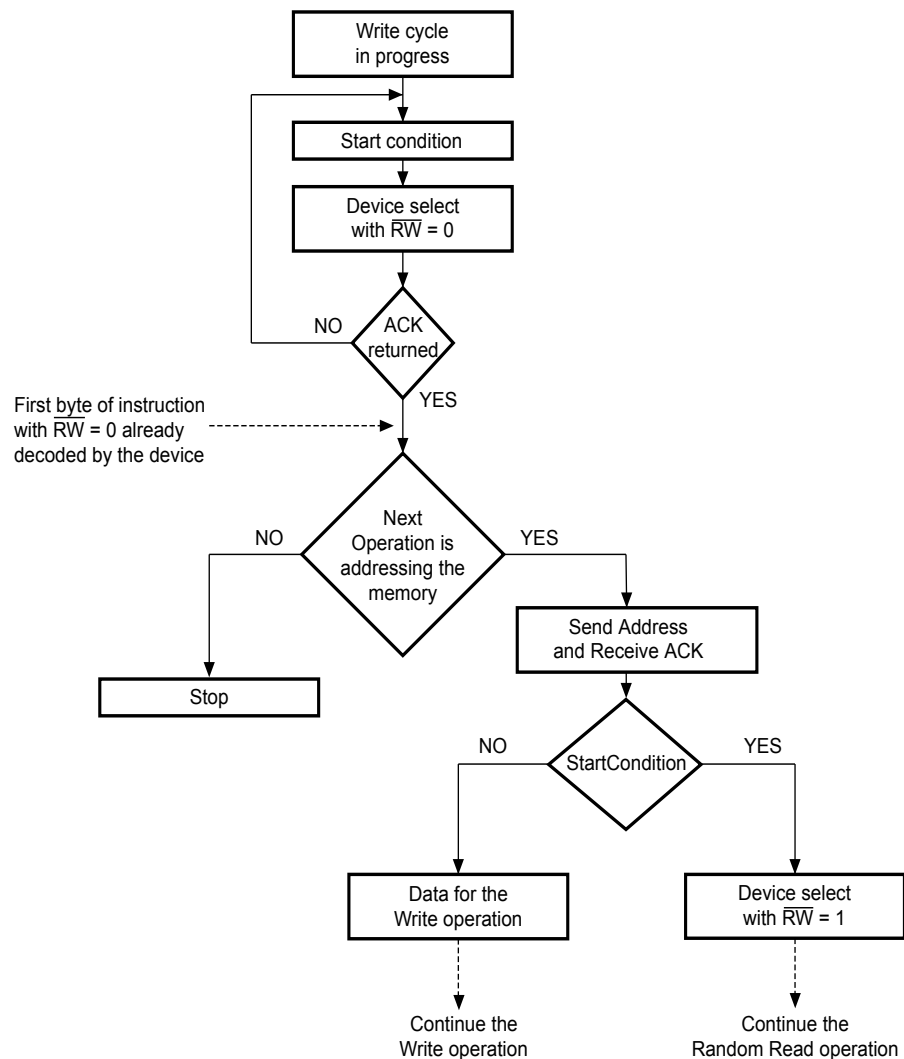
The sequence, as shown in [Figure 34. Write cycle polling flowchart using ACK](#) is:

- Initial condition: a write cycle is in progress.
- Step 1: the bus master issues a Start condition followed by a device select code (the first byte of the new instruction).
- Step 2: if the device is busy with the internal write cycle, no Ack is returned and the bus master goes back to Step 1. If the device has terminated the internal write cycle, it responds with an Ack, indicating that the device is ready to receive the second part of the instruction (the first byte of this instruction having been sent during Step 1).



Note: There is no need of polling when writing in dynamic registers or in mailbox, since programming time is null.

**Figure 34. Write cycle polling flowchart using ACK**



## 6.5 I<sup>2</sup>C read operations

Read operation in user memory is performed successfully only if:

- Area to which the byte belongs is not read protected by the I2CSS register.
- Area to which the byte belongs is read protected by the I2CSS register, but I<sup>2</sup>C security session is open.

Read operations in system memory and dynamic registers are done independently of any protection mechanism, except I2C\_PWD register which needs I<sup>2</sup>C security session to be open first.

Read operation in fast transfer mode's mailbox is performed successfully only if fast transfer mode is activated.

If read is not successful, ST25DVxxKC releases the bus and I<sup>2</sup>C host reads byte value FFh.

After the successful completion of a read operation, the device's internal address counter is incremented by one, to point to the next byte address.

After an unsuccessful read operation, ST25DVxxKC enters in I<sup>2</sup>C dead state: internal address counter is not incremented, and ST25DVxxKC is waiting for a full new I<sup>2</sup>C instruction.

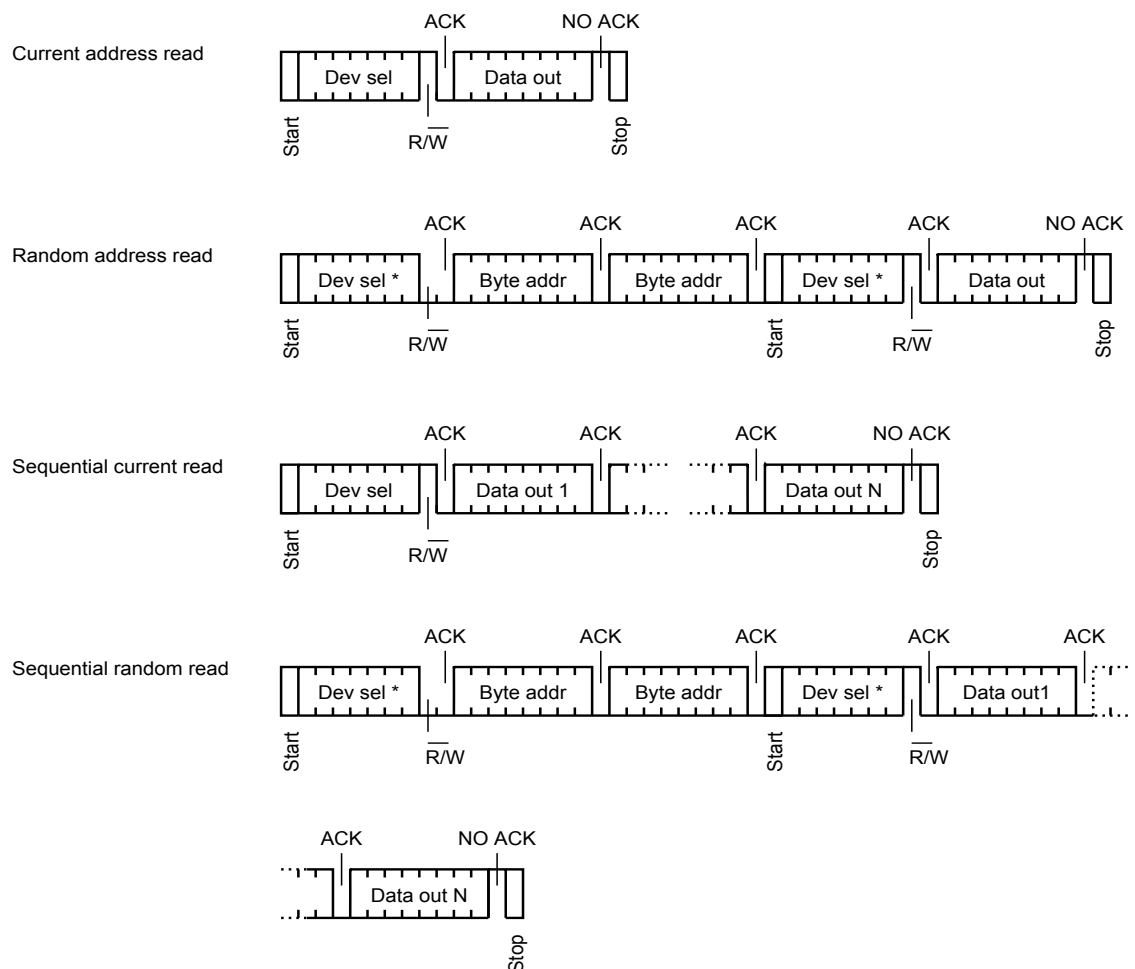
### 6.5.1 Random address read

A dummy write is first performed to load the address into this address counter (as shown in [Figure 35. Read mode sequences](#)) but without sending a Stop condition. Then, the bus master sends another Start condition (aka reStart), and repeats the device select code, with the Read/Write bit (RW) set to 1. The device acknowledges this, and outputs the contents of the addressed byte. The bus master must not acknowledge the byte, and terminates the transfer with a Stop condition.

### 6.5.2 Current address read

For the Current address read operation, following a Start condition, the bus master only sends a device select code with the Read/Write bit (RW) set to 1. The device acknowledges this, and outputs the byte addressed by the internal address counter. The counter is then incremented. The bus master terminates the transfer with a Stop condition, as shown in the figure below, without acknowledging the byte.

**Figure 35. Read mode sequences**



### 6.5.3 Sequential read access

This operation can be used after a Current address read or a Random address read. The bus master does acknowledge the data byte output, and sends additional clock pulses so that the device continues to output the next byte in sequence. To terminate the stream of bytes, the bus master must not acknowledge the last byte, and must generate a Stop condition, as shown in [Figure 35. Read mode sequences](#).

The output data comes from consecutive addresses, with the internal address counter automatically incremented after each byte output.

Sequential read in user memory:

- Sequential read can cross area borders. Device continue to output data bytes until the internal address counter is reaching a non readable address (either address that don't exist or if read protected with I<sup>2</sup>C security session closed).
- When internal address counter reach a non readable address, device releases the SDA line and continues to output FFh.
- There is no roll over at the end of user memory. When internal address counter reaches end of user memory, device continue to output bytes located in Dynamic registers area, until it reaches a non readable address.

Sequential read in system memory:

- There is no roll over after reaching end of system memory (ST25DVxxKC returns only FFh after last system memory byte address).

Sequential read in dynamic registers:

- It is possible to read sequentially dynamic register and fast transfer mode's mailbox (contiguous I<sup>2</sup>C addresses). There is no roll over at the end of dynamic registers area.

Sequential read in mailbox:

- There is no roll over at the end of the mailbox (ST25DVxxKC returns only FFh after last mailbox memory byte address).

#### 6.5.4 Acknowledge in read mode

For all Read commands, the device waits, after each byte read, for an acknowledgement during the ninth bit time. If the bus master does not drive serial data (SDA) low during this time, the device terminates the data transfer and switches to its Standby mode.

## 6.6 I<sup>2</sup>C password management

The controls I<sup>2</sup>C security session using an I<sup>2</sup>C 64-bit password. This I<sup>2</sup>C password is managed with two I<sup>2</sup>C dedicated commands: I<sup>2</sup>C present password and I<sup>2</sup>C write password.

### 6.6.1 I<sup>2</sup>C present password command description

The I<sup>2</sup>C present password command is used in I<sup>2</sup>C mode to present the password to the ST25DVxxKC. This is used to open I<sup>2</sup>C security session or to allow I<sup>2</sup>C password modification (see [Section 5.6 Data protection](#) for detailed explanation about password usage).

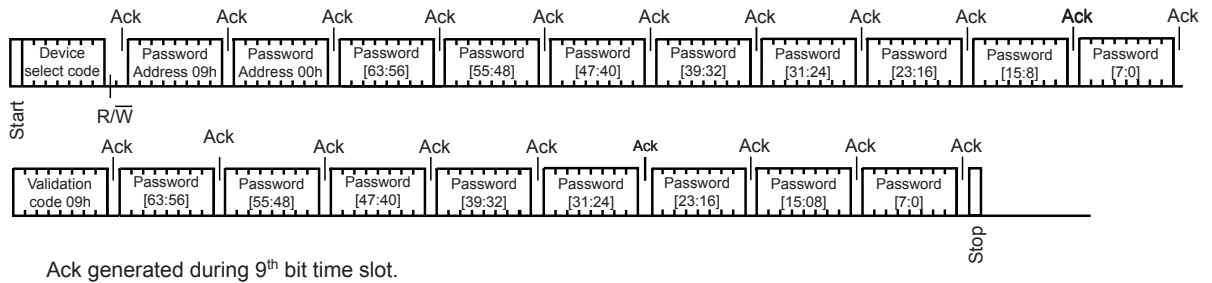
Following a Start condition, the bus master sends a device select code with the Read/ $\overline{\text{Write}}$  bit ( $\overline{\text{RW}}$ ) reset to 0 and the Chip Enable bit E2 at 1 and E1 at 1. The device acknowledges this, as shown in [Figure 36. I<sup>2</sup>C Present Password Sequence](#), and waits for two I<sup>2</sup>C password address bytes, 09h and 00h. The device responds to each address byte with an acknowledge bit, and then waits for the eight password data bytes, the validation code, 09h, and a resend of the eight password data bytes. The most significant byte of the password is sent first, followed by the least significant bytes.

It is necessary to send the 64-bit password twice to prevent any data corruption during the sequence. If the two 64-bit passwords sent are not exactly the same, the ST25DVxxKC does not start the internal comparison.

When the bus master generates a Stop condition, immediately after the Ack bit (during the tenth bit time slot), the ST25DVxxKC compares the 64 received data bits with the 64 bits of the stored I<sup>2</sup>C password. If the values match, the I<sup>2</sup>C security session is open, and the I2C\_SSO\_Dyn register is set to 01h. If the values do not match, the I<sup>2</sup>C security session is closed and I2C\_SSO\_dyn register is set to 00h.

I2C\_SSO\_Dyn is a Dynamic register, it can be checked via I<sup>2</sup>C host to know If I<sup>2</sup>C security session is open.

Figure 36. I<sup>2</sup>C Present Password Sequence



### 6.6.2 I<sup>2</sup>C write password command description

The I<sup>2</sup>C write password command is used to update the I<sup>2</sup>C password value (register I2C\_PWD). It cannot be used to update any of the RF passwords. After the write cycle, the new I<sup>2</sup>C password value is automatically activated. The I<sup>2</sup>C password value can only be modified after issuing a valid I<sup>2</sup>C present password command. Following a Start condition, the bus master sends a device select code with the Read/Write bit ( $\overline{RW}$ ) reset to 0 and the Chip Enable bit E2 at 1 and E1 at 1. The device acknowledges this, as shown in Figure 37. I<sup>2</sup>C Write Password Sequence, and waits for the two I<sup>2</sup>C password address bytes, 09h and 00h. The device responds to each address byte with an acknowledge bit, and then waits for the four password data bytes, the validation code, 07h, and a resend of the eight password data bytes. The most significant byte of the password is sent first, followed by the least significant bytes.

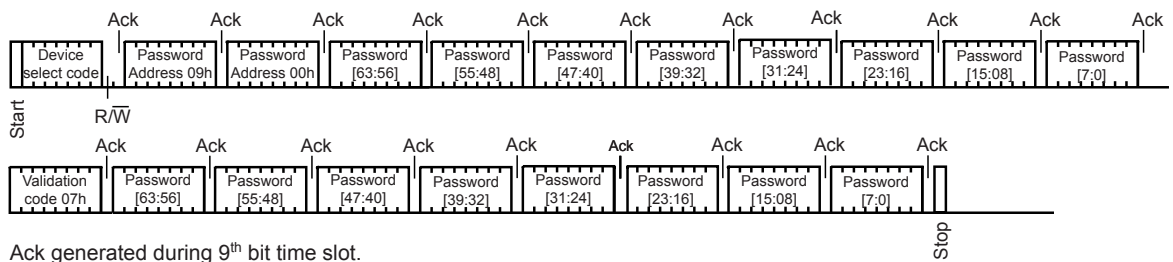
It is necessary to send twice the 64-bit password to prevent any data corruption during the write sequence. If the two 64-bit passwords sent are not exactly the same, the ST25DVxxKC does not modify the I<sup>2</sup>C password value.

When the bus master generates a Stop condition immediately after the Ack bit (during the tenth bit time slot), the internal write cycle is triggered. A Stop condition at any other time does not trigger the internal write cycle.

During the internal write cycle, the serial data (SDA) signal is disabled internally, and the device does not respond to any requests.

**Caution:** I<sup>2</sup>C write password command data transits via the 256-byte fast transfer mode's buffer. Consequently fast transfer mode must be deactivated before issuing a write password command, otherwise command is NotACK (after address LSB), and programming is not done and device goes in standby mode.

Figure 37. I<sup>2</sup>C Write Password Sequence



## 7 RF operations

Contactless exchanges are performed in RF mode as specified by ISO/IEC 15693 or NFC Forum Type 5. The ST25DVxxKC communicates via the 13.56 MHz carrier electromagnetic wave on which incoming data are demodulated from the received signal amplitude modulation (ASK: amplitude shift keying). The received ASK wave is 10% or 100% modulated with a data rate of 1.6 kbit/s using the 1/256 pulse coding mode or a data rate of 26 kbit/s using the 1/4 pulse coding mode.

Outgoing data are generated by the ST25DVxxKC load variation using Manchester coding with one or two subcarrier frequencies at 423 kHz and 484 kHz. Data are transferred from the ST25DVxxKC at 6.6 kbit/s in low data rate mode and 26 kbit/s in high data rate mode. The ST25DVxxKC supports the 53 kbit/s in high data rate mode in one subcarrier frequency at 423 kHz.

The ST25DVxxKC follows ISO/IEC 15693 or NFC Forum Type 5 recommendation for radio-frequency power and signal interface and for anticollision and transmission protocol.

### 7.1 RF communication

#### 7.1.1 Access to a ISO/IEC 15693 device

**The dialog between the “RF reader” and the ST25DVxxKC takes place as follows:**

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

- activation of the ST25DVxxKC by the RF operating field of the reader,
- transmission of a command by the reader (ST25DVxxKC detects carrier amplitude modulation)
- transmission of a response by the ST25DVxxKC (ST25DVxxKC modulates its load clocked at subcarrier rate)

#### **Operating field**

The ST25DVxxKC operates continuously between the minimum and maximum values of the electromagnetic field H defined in [Table 256. RF characteristics](#). The Reader has to generate a field within these limits.

#### **Power transfer**

Power is transferred to the ST25DVxxKC by radio frequency at 13.56 MHz via coupling antennas in the ST25DVxxKC and the Reader. The RF operating field of the reader is transformed on the ST25DVxxKC 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  $\pm$ 7 kHz.

### 7.2 RF communication and energy harvesting

As the current consumption can affect the AC signal delivered by the antenna, RF communications with ST25DVxxKC are not guaranteed during voltage delivery on the energy harvesting analog output V\_EH.

### 7.3 Fast transfer mode mailbox access in RF

Thanks to dedicated commands, the RF interface has the possibility to check Mailbox availability, and the capability to access it directly to put or get a message from it (see [Section 5.1 Fast transfer mode \(FTM\)](#) for specific features).

## 7.4 RF protocol description

### 7.4.1 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 ST25DVxxKC in both directions. It is based on the concept of “VCD talks first”.

This means that a ST25DVxxKC 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:

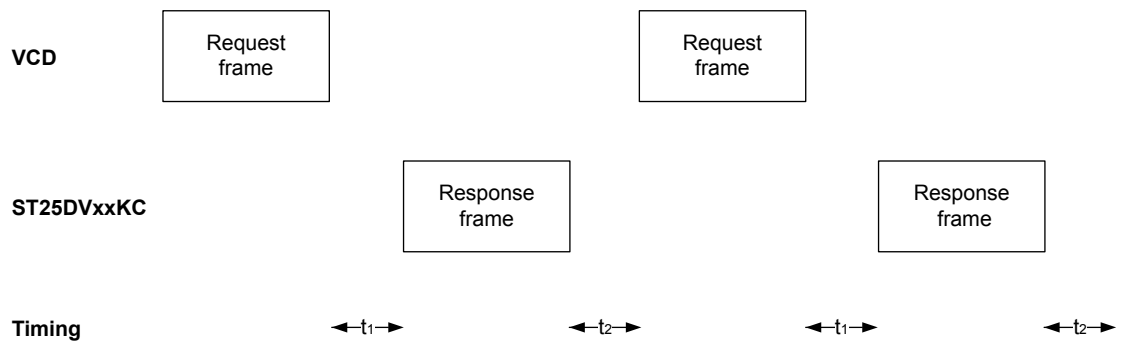
- a request from the VCD to the ST25DVxxKC,
- a response from the ST25DVxxKC to the VCD.

Each request and each response are contained in a frame. The frame 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 38. ST25DVxxKC protocol timing**



### 7.4.2 ST25DVxxKC states referring to RF protocol

The ST25DVxxKC can be in one of four states:

- Power-off
- Ready
- Quiet
- Selected

Transitions between these states are specified in [Figure 39. ST25DVxxKC state transition diagram](#) and [Table 95. ST25DVxxKC response depending on Request\\_flags](#).

#### Power-off state

The ST25DVxxKC is in the Power-off state when it does not receive enough energy from the VCD.

#### Ready state

The ST25DVxxKC is in the Ready state when it receives enough energy from the VCD. When in the Ready state, the ST25DVxxKC answers any request where the Select\_flag is not set.

### Quiet state

When in the Quiet state, the ST25DVxxKC answers any request with the Address\_flag set, except for Inventory requests.

### Selected state

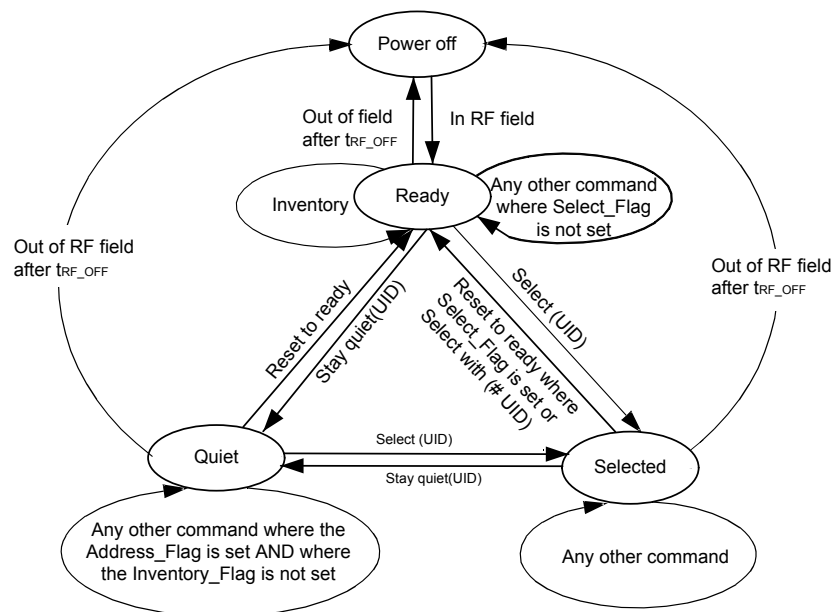
In the Selected state, the ST25DVxxKC answers any request in all modes (see Section 7.4.3 Modes):

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

**Table 95. ST25DVxxKC response depending on Request\_flags**

Flags	Address_flag		Select_flag	
	1 Addressed	0 Non addressed	1 Selected	0 Non selected
ST25DVxxKC in Ready or Selected state (Devices in Quiet state do not answer)	-	X	-	X
ST25DVxxKC in Selected state	-	X	X	-
ST25DVxxKC in Ready, Quiet or Selected state (the device which matches the UID)	X	-	-	X
Error (03h) or no response (command dependent)	X	-	X	-

**Figure 39. ST25DVxxKC state transition diagram**



1. The ST25DVxxKC returns to the Power Off state if the tag is out of the RF field for at least  $t_{RF\_OFF}$ . The intention of the state transition method is that only one ST25DVxxKC should be in the Selected state at a time.

When the `Select_flag` is set to 1, the request shall NOT contain a unique ID.  
 When the `address_flag` is set to 0, the request shall NOT contain a unique ID.

### 7.4.3 Modes

The term “mode” refers to the mechanism used in a request to specify the set of ST25DVxxKC 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 ST25DVxxKC.

Any ST25DVxxKC that receives a request with the `Address_flag` set to 1 compares the received Unique ID to its own. If it matches, then the ST25DVxxKC 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 ST25DVxxKC 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 ST25DVxxKC in the Selected state answers a request where the `Select_flag` is set to 1.

The system design ensures that only one ST25DVxxKC can be in the Select state at a time.

### 7.4.4 Request format

The request consists of:

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

**Table 96. General request format**

SOF	Request_flags	Command code	Parameters	Data	2 byte CRC	EOF
-----	---------------	--------------	------------	------	------------	-----

### 7.4.5 Request flags

In a request, the “flags” field specifies the actions to be performed by the ST25DVxxKC 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 ST25DVxxKC selection criteria. When bit 3 is set (1), bits 5 to 8 define the ST25DVxxKC Inventory parameters.



**Table 97. Definition of request flags 1 to 4**

Bit No	Flag	Level	Description
Bit 1	Subcarrier_flag <sup>(1)</sup>	0	A single subcarrier frequency is used by the ST25DVxxKC
		1	Two subcarriers are used by the ST25DVxxKC
Bit 2	Data_rate_flag <sup>(2)</sup>	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 <a href="#">Table 98</a>
		1	The meaning of flags 5 to 8 is described in <a href="#">Table 99</a>
Bit 4	Protocol_extension_flag	0	No Protocol format extension
		1	Protocol format extension. Reserved for future use.

1. *Subcarrier\_flag* refers to the ST25DVxxKC-to-VCD communication.

2. *Data\_rate\_flag* refers to the ST25DVxxKC-to-VCD communication.

**Table 98. Request flags 5 to 8 when inventory\_flag, Bit 3 = 0**

Bit nb	Flag	Level	Description
Bit 5	Select flag <sup>(1)</sup>	0	The request is executed by any ST25DVxxKC according to the setting of Address_flag
		1	The request is executed only by the ST25DVxxKC in Selected state
Bit 6	Address flag	0	The request is not addressed. UID field is not present. The request is executed by all ST25DVxxKCs.
		1	The request is addressed. UID field is present. The request is executed only by the ST25DVxxKC 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 99. 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	-

### 7.4.6 Response format

The response consists of:

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

**Table 100. General response format**

SOF	Response_flags	Parameters	Data	2 byte CRC	EOF
-----	----------------	------------	------	------------	-----

### 7.4.7 Response flags

In a response, the flags indicate how actions have been performed by the ST25DVxxKC and whether corresponding fields are present or not. The response flags consist of eight bits.

**Table 101. 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	ResponseBuffer Validity_flag	0	Not supported, always set to 0
Bit 3	Final response_flag	0	Not supported, always set to 0
Bit 4	Extension flag	0	Not supported, always set to 0
Bit 6-5	Block security status length_flag	0	Not supported, always set to 0
Bit 7	Waiting time extension request_flag	0	Not supported, always set to 0
Bit 8	RFU	0	-

### 7.4.8 Response and error code

If the Error\_flag is set by the ST25DVxxKC in the response, the Error code field is present and provides information about the error that occurred.

Error codes not specified in [Table 102](#) are reserved for future use.

**Table 102. 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.

## 7.5 Timing definition

### **t<sub>1</sub>: ST25DVxxKC response delay**

Upon detection of the rising edge of the EOF received from the VCD, the ST25DVxxKC 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 103. Timing values](#).

### **t<sub>2</sub>: 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 ST25DVxxKC responses have been received during an Inventory command. It starts from the reception of the EOF from the ST25DVxxKCs.

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 ST25DVxxKC.

$t_2$  is also the time after which the VCD may send a new request to the ST25DVxxKC, as described in [Figure 38. ST25DVxxKC protocol timing](#).

Values of  $t_2$  are given in [Table 103](#).

### **t<sub>3</sub>: VCD new request delay when no response is received from the ST25DVxxKC**

$t_3$  is the time after which the VCD may send an EOF to switch to the next slot when no ST25DVxxKC 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 ST25DVxxKC.

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 103. Timing values**

	Minimum (min) values		Nominal (nom) values	Maximum (max) values
	100% modulation	10% modulation		
$t_1$	$4320 / f_c = 318.6 \mu\text{s}$		$4352 / f_c = 320.9 \mu\text{s}$	$4384 / f_c = 323.3 \mu\text{s}^{(1)}$
$t_2$	$4192 / f_c = 309.2 \mu\text{s}$		No $t_{\text{nom}}$	No $t_{\text{max}}$
$t_3$	$t_{1\text{max}}^{(2)} + t_{\text{SOF}}^{(3)}$	$t_{1\text{max}}^{(2)} + t_{\text{NRT}}^{(4)} + t_{2\text{min}}$	No $t_{\text{nom}}$	No $t_{\text{max}}$

- VCD request is interpreted during the first milliseconds following the RF field rising.*
- $t_{1\text{max}}$  does not apply for write-alike requests. Timing conditions for write-alike requests are defined in the command description.*
- $t_{\text{SOF}}$  is the time taken by the ST25DVxxKC to transmit an SOF to the VCD.  $t_{\text{SOF}}$  depends on the current data rate: High data rate or Low data rate.*
- $t_{\text{NRT}}$  is the nominal response time of the ST25DVxxKC.  $t_{\text{NRT}}$  depends on  $V_{\text{ICC}}$  to ST25DVxxKC data rate and subcarrier modulation mode.*

**Note:** The tolerance of specific timings is  $\pm 32/f_c$ .

## 7.6 RF commands

### 7.6.1 RF command code list

The ST25DVxxKC supports the following legacy and extended RF command set:

- **Inventory**, used to perform the anticollision sequence.
- **Stay Quiet**, used to put the ST25DVxxKC in quiet mode, where it does not respond to any inventory command.
- **Select**, used to select the ST25DVxxKC. After this command, the ST25DVxxKC processes all Read/Write commands with Select\_flag set.
- **Reset To Ready**, used to put the ST25DVxxKC 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** and **Extended Get System Information**, used to provide the system information value.
- **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 Message**, used to output up to 256 byte of the Mailbox.
- **Read Message Length**, used to output the Mailbox message length.
- **Fast Read Message**, used to output up to 256 byte of the mailbox, at double data rate.
- **Write Message**, used to write up to 256 byte in the Mailbox.
- **Fast Read Message Length**, used to output the mailbox length, at double data rate.
- **Fast Write Message**, used to write up to 256 bytes in the mailbox, with answer at double data rate.
- **Read Configuration**, used to read static configuration registers.
- **Write Configuration**, used to write static configuration registers.
- **Read Dynamic Configuration**, used to read dynamic register.
- **Write Dynamic Configuration**, used to write dynamic register.
- **Fast Read Dynamic Configuration**, used to read dynamic register, at double data rate.
- **Fast Write Dynamic Configuration**, used to write dynamic register, with answer at double data rate.
- **Manage GPO**, used to drive GPO output value when corresponding GPO mode is enabled.

### 7.6.2 Command codes list

The ST25DVxxKC supports the commands described in this section. Their codes are given in [Table 104](#).

**Table 104. 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	A9h	Manage GPO
21h	Write Single Block	AAh	Write Message
22h	Lock Block	ABh	Read Message Length
23h	Read Multiple Blocks	ACh	Read Message
24h	Write Multiple Blocks	ADh	Read Dynamic Configuration
25h	Select	A Eh	Write Dynamic Configuration
26h	Reset to Ready	B1h	Write Password
27h	Write AFI	B3h	Present Password
28h	Lock AFI	C0h	Fast Read Single Block
29h	Write DSFID	C3h	Fast Read Multiple Blocks
2Ah	Lock DSFID	CDh	Fast Read Dynamic configuration
2Bh	Get System Info	CEh	Fast Write Dynamic Configuration
2Ch	Get Multiple Block Security Status	-	-
30h	Extended Read Single Block	C4h	Fast Extended Read Single Block
31h	Extended Write Single Block	C5h	Fast Extended Read Multiple Block
32h	Extended Lock block	CAh	Fast Write Message
33h	Extended Read Multiple Blocks	CBh	Fast Read Message Length
34h	Extended Write Multiple Blocks	CCh	Fast Read Message
3Bh	Extended Get System Info	-	-
3Ch	Extended Get Multiple Block Security Status	-	-

### 7.6.3 General command rules

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

But in case of an invalid command, in a general manner, the ST25DVxxKC behaves as follows:

1. If flag usage is incorrect, the error code 03h is issued only if the right UID is used in the command, otherwise no response is issued.
2. The error code 02h is issued if the custom command is used with the manufacturer code different from the ST one.

Another case is if I<sup>2</sup>C is busy. In this case, any RF command (except Inventory, Select, Stay quiet and Reset to ready) gets 0Fh error code as response only:

- If select flag and address flags are not set at the same time (except if ST25DVxxKC is in quiet state)
- If select flag is set and ST25DVxxKC is in selected state.

For all other commands, if I<sup>2</sup>C is busy, no response is issued by ST25DVxxKC.

### 7.6.4 Inventory

Upon receiving the Inventory request, the ST25DVxxKC runs the anticollision sequence. The Inventory\_flag is set to 1. The meaning of flags 5 to 8 is shown in Table 99. Request flags 5 to 8 when inventory\_flag, Bit 3 = 1.

The request contains:

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

The ST25DVxxKC does not generate any answer in case of error.

**Table 105. 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 106. 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 ST25DVxxKC 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:  

$$t_{3min} = 4384/f_C (323.3\mu s) + t_{SOF}$$
- If the VCD sends a 10% modulated EOF, the minimum value of  $t_3$  is:  

$$t_{3min} = 4384/f_C (323.3\mu s) + t_{NRT} + t_{2min}$$

where:

- $t_{SOF}$  is the time required by the ST25DVxxKC to transmit an SOF to the VCD,
- $t_{NRT}$  is the nominal response time of the ST25DVxxKC.

$t_{NRT}$  and  $t_{SOF}$  are dependent on the ST25DVxxKC-to-VCD data rate and subcarrier modulation mode.

*Note:* In case of error, no response is sent by ST25DVxxKC.

### 7.6.5 Stay Quiet

On receiving the Stay Quiet command, the ST25DVxxKC 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 ST25DVxxKC does not process any request if the Inventory\_flag is set,
- the ST25DVxxKC processes any Addressed request.

The ST25DVxxKC exits the Quiet state when:

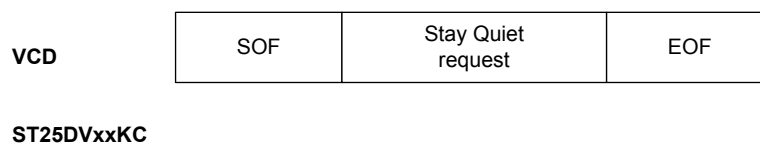
- it is reset (power off),

- 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 107. 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 40. Stay Quiet frame exchange between VCD and ST25DVxxKC**


### 7.6.6 Read Single Block

On receiving the Read Single Block command, the ST25DVxxKC 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 ST25DV16KC and ST25DV64KC can be addressed using this command.

**Table 108. Read Single Block request format**

Request SOF	Request_flags	Read Single Block	UID <sup>(1)</sup>	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

**Table 109. Read Single Block response format when Error\_flag is NOT set**

Response SOF	Response_flags	Block security status <sup>(1)</sup>	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 110. Block security status)
- Four bytes of block data



**Table 110. Block security status**

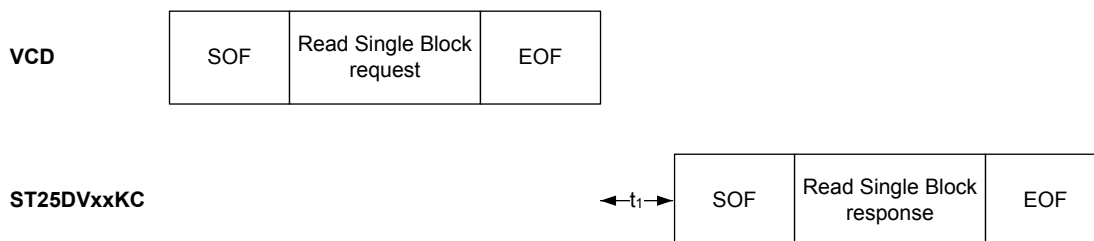
b <sub>7</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	b <sub>0</sub>
Reserved for future use. All at 0.							0: Current block not locked 1: Current block locked

**Table 111. 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 41. Read Single Block frame exchange between VCD and ST25DVxxKC**


### 7.6.7

#### Extended Read Single Block

On receiving the Extended Read Single Block command, the ST25DVxxKC 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.

Block number is coded on 2 Bytes so all memory blocks of ST25DV16KC and ST25DV64KC can be addressed using this command.

**Table 112. Extended Read Single Block request format**

Request SOF	Request_flags	Extended Read Single Block	UID <sup>(1)</sup>	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 113. Extended Read Single Block response format when Error\_flag is NOT set**

Response SOF	Response_flags	Block security status <sup>(1)</sup>	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 114)
- Four bytes of block data

**Table 114. Block security status**

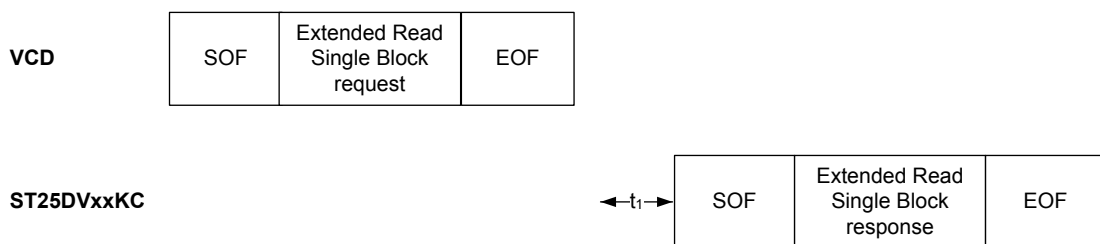
b <sub>7</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	b <sub>0</sub>
Reserved for future use. All at 0.							0: Current block not locked 1: Current block locked

**Table 115. 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 42. Extended Read Single Block frame exchange between VCD and ST25DVxxKC**


### 7.6.8 Write Single Block

On receiving the Write Single Block command, the ST25DVxxKC 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 ST25DVxxKC may not program correctly the data into the memory. The  $W_t$  time is equal to  $t_{1nom} + N \times 302 \mu s$  (N is an integer).

Block number is coded on 1 Byte and only first 256 blocks of ST25DV16KC and ST25DV64KC can be addressed using this command.

**Table 116. Write Single Block request format**

Request SOF	Request_flags	Write Single Block	UID <sup>(1)</sup>	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 117. 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.

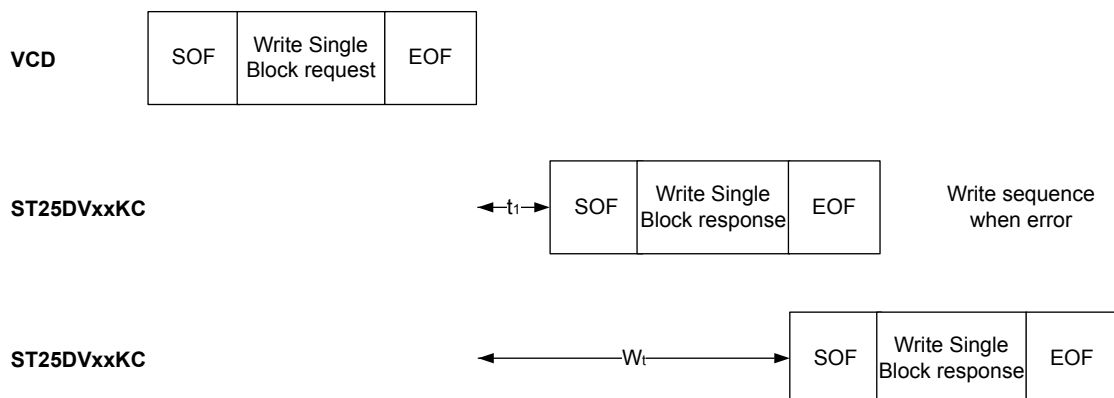
**Table 118. Write Single Block response format when Error\_flag is set**

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

*Note:* For more details, see [Figure 9. Memory organization](#).

**Figure 43. Write Single Block frame exchange between VCD and ST25DVxxKC**


### 7.6.9 Extended Write Single Block

On receiving the Extended Write Single command, the ST25DVxxKC 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 ST25DVxxKC may not program correctly the data into the memory. The  $W_t$  time is equal to  $t_{1nom} + N \times 302 \mu s$  (N is an integer).

Block number is coded on 1 Byte and only first 256 blocks of ST25DV16KC and ST25DV64KC can be addressed using this command.

**Table 119. Extended Write Single request format**

Request SOF	Request_flags	Extended Write Single Block	UID <sup>(1)</sup>	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 120. Extended Write Single response format when Error\_flag is NOT set**

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

Response parameter:

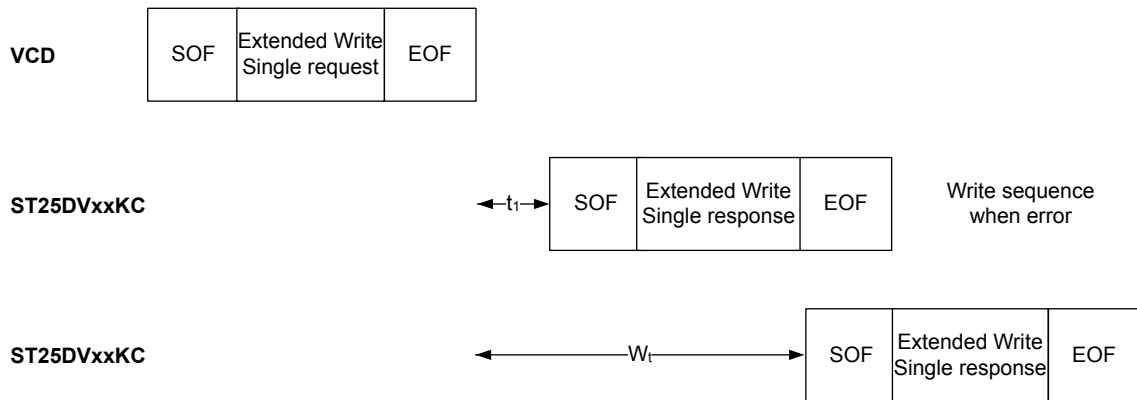
- No parameter. The response is sent back after the writing cycle.

**Table 121. 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 44. Extended Write Single frame exchange between VCD and ST25DVxxKC**


### 7.6.10 Lock Block

On receiving the Lock block request, the ST25DVxxKC 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  $RFA_iSS$  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 ST25DVxxKC may not lock correctly the single block value in memory. The  $W_t$  time is equal to  $t_{1nom} + N \times 302 \mu s$  ( $N$  is an integer).

**Table 122. Lock block request format**

Request SOF	Request_flags	Lock block	UID <sup>(1)</sup>	block number	CR7C16	Request EOF
-	8 bits	22h	64 bits	8 bits	16 bits	-

1. This field is optional.

Request parameter:

- Request Flags
- UID (optional)
- Only block numbers 0 and 1 are allowed to protect the CCFile in case of NDEF (from LSB byte to MSB byte)

**Table 123. 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

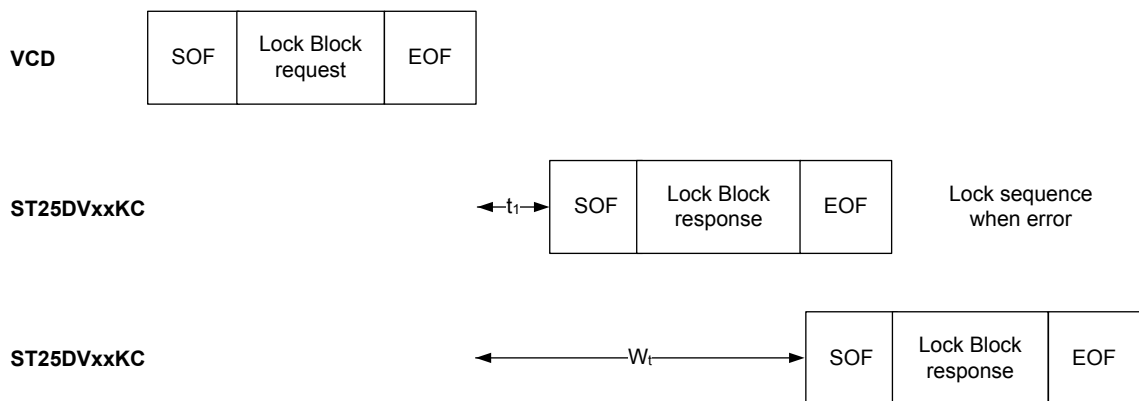
**Table 124. Lock block response format when Error\_flag is set**

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 45. Lock Block frame exchange between VCD and ST25DVxxKC**



### 7.6.11 Extended Lock block

On receiving the extended Lock block request, the ST25DVxxKC 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 ST25DVxxKC may not lock correctly the single block value in memory. The  $W_t$  time is equal to  $t_{1nom} + N \times 302 \mu s$  (N is an integer).

**Table 125. Extended Lock block request format**

Request SOF	Request_flags	Extended Lock block	UID <sup>(1)</sup>	block number	CRC16	Request EOF
-	8 bits	32h	64 bits	16 bits	16 bits	-

1. The field is optional.

Request parameter:

- Request Flags
- UID (optional)
- Only block numbers 0 and 1 are allowed to protect the CCFile in case of NDEF (from LSB byte to MSB byte)

**Table 126. 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

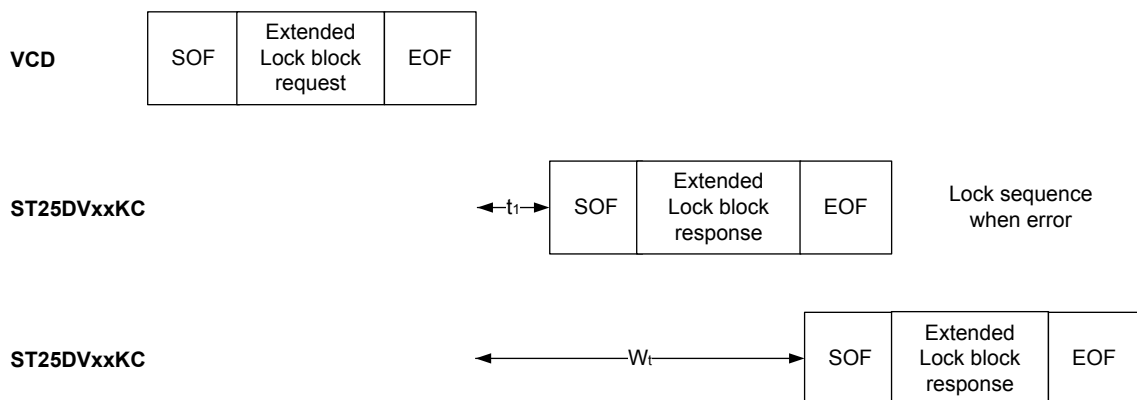
**Table 127. Extended Lock block response format when Error\_flag is set**

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 46. Extended Lock block frame exchange between VCD and ST25DVxxKC**



### 7.6.12 Read Multiple Blocks

When receiving the Read Multiple Block command, the ST25DVxxKC 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 ST25DV16KC and ST25DV64KC can be addressed using this command.

**Table 128. Read Multiple Block request format**

Request SOF	Request_flags	Read Multiple Block	UID <sup>(1)</sup>	First block number	Number of blocks	CRC16	Request EOF
-	8 bits	23h	64 bits	8 bits	8 bits	16 bits	-

1. The field is optional.

Request parameters:

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

**Table 129. Read Multiple Block response format when Error\_flag is NOT set**

Response SOF	Response_ flags	Block security status <sup>(1)</sup>	Data	CRC16	Response EOF
-	8 bits	8 bits <sup>(2)</sup>	32 bits <sup>(2)</sup>	16 bits	-

1. The field is optional.

2. Repeated as needed.

Response parameters:

- Block security status if Option\_flag is set (see Table 130. Block security status)
- N blocks of data

**Table 130. Block security status**

b <sub>7</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	b <sub>0</sub>
Reserved for future use. All at 0.							0: Current block not locked 1: Current block locked

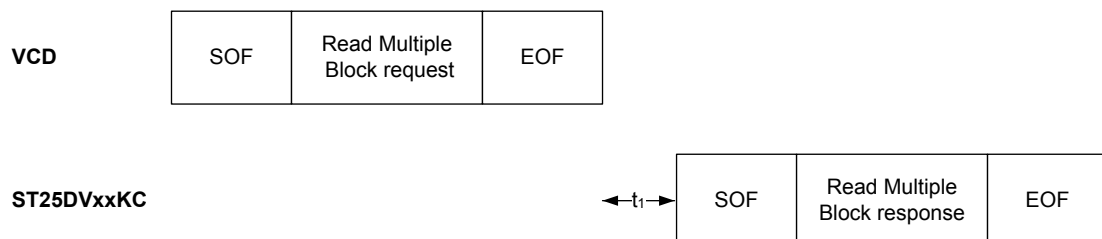
**Table 131. Read Multiple Block response format when Error\_flag is set**

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 47. Read Multiple Block frame exchange between VCD and ST25DVxxKC**





### 7.6.13 Extended Read Multiple Blocks

When receiving the Extended Read multiple block command, the ST25DVxxKC 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 ST25DV16KC and ST25DV64KC can be addressed using this command.

**Table 132. Extended Read Multiple Block request format**

Request SOF	Request_flags	Extended Read Multiple Block	UID <sup>(1)</sup>	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 133. Extended Read Multiple Block response format when Error\_flag is NOT set**

Response SOF	Response_flags	Block security status <sup>(1)</sup>	Data	CRC16	Response EOF
-	8 bits	8 bits <sup>(2)</sup>	32 bits <sup>(2)</sup>	16 bits	-

1. This field is optional.

2. Repeated as needed.

Response parameters:

- Block security status if Option\_flag is set (see Table 130)
- N blocks of data

**Table 134. Block security status**

b <sub>7</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	b <sub>0</sub>
Reserved for future use. All at 0							0: Current block not locked 1: Current block locked

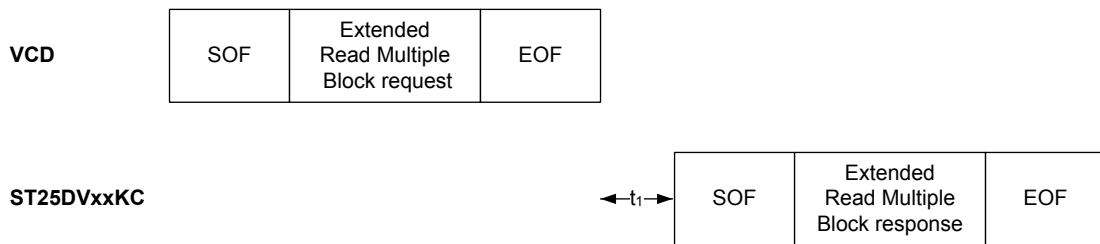
**Table 135. Extended Read Multiple Block response format when Error\_flag is set**

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 48. Extended Read Multiple Block frame exchange between VCD and ST25DVxxKC**



### 7.6.14 Write Multiple Blocks

On receiving the Write Multiple Block command, the ST25DVxxKC writes the data contained in the request to the requested blocks, and reports whether the write operation were successful in the response. ST25DVxxKC 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 ST25DVxxKC 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 ST25DVxxKC 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 ST25DVxxKC may not program correctly the data into the memory. The  $W_t$  time is equal to  $t_{1nom} + m \times 302 \mu s < 20 ms$ . ( $m$  is an integer, it is function of  $N_b$  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 ST25DV16KC and ST25DV64KC can be addressed using this command.

**Table 136. Write Multiple Block request format**

Request SOF	Request_flags	Write Multiple Block	UID <sup>(1)</sup>	First Block number	Number of block <sup>(2)</sup>	Data	CRC16	Request EOF
-	8 bits	24h	64 bits	8 bits	8 bits	Block length <sup>(3)</sup>	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 137. Write Multiple Block response format when Error\_flag is NOT set**

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

Response parameter:

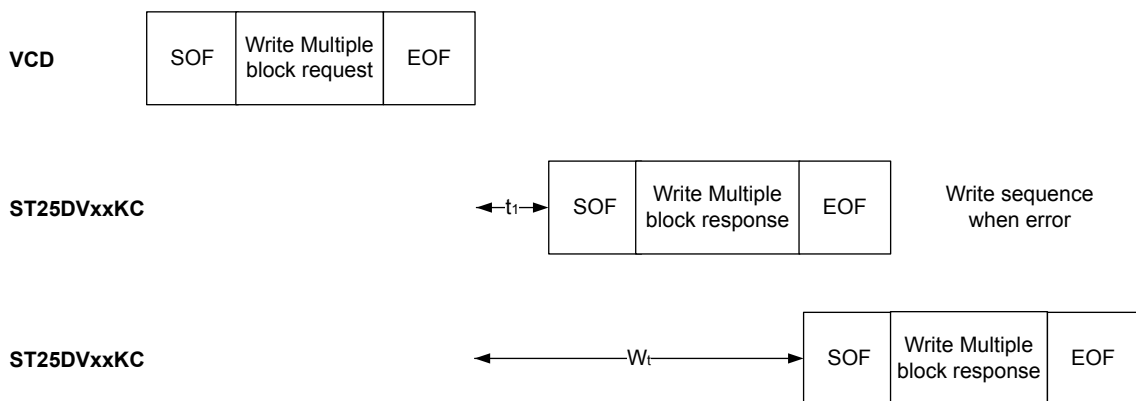
- No parameter. The response is sent back after the writing cycle.

**Table 138. 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 49. Write Multiple Block frame exchange between VCD and ST25DVxxKC**


### 7.6.15 Extended Write Multiple Blocks

On receiving the Extended Write multiple block command, the writes the data contained in the request to the targeted blocks and reports whether the write operation were successful in the response. ST25DVxxKC supports up to 4 blocks, data field must be coherent with number of blocks to program.

If some blocks overlaps areas, or overlap end of user memory the ST25DVxxKC returns an error code and none of the blocks are programmed.

The number of blocks in the request is one less than the number of blocks that the ST25DVxxKC shall write (for instance Number of block = 2 means 3 blocks to be written).

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 ST25DVxxKC may not program correctly the data into the memory. The  $W_t$  time is equal to  $t_{1nom} + m \times 302 \mu s < 20 \text{ ms}$  ( $m$  is an integer function of  $N_b$  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 ST25DV16KC and ST25DV64KC can be addressed using this command.

**Table 139. Extended Write Multiple Block request format**

Request SOF	Request_flags	Extended Write multiple block	UID <sup>(1)</sup>	First Block number	Number of block <sup>(2)</sup>	Data	CRC16	Request EOF
-	8 bits	34h	64 bits	16 bits	16 bits	Block length <sup>(3)</sup>	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 140. 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:

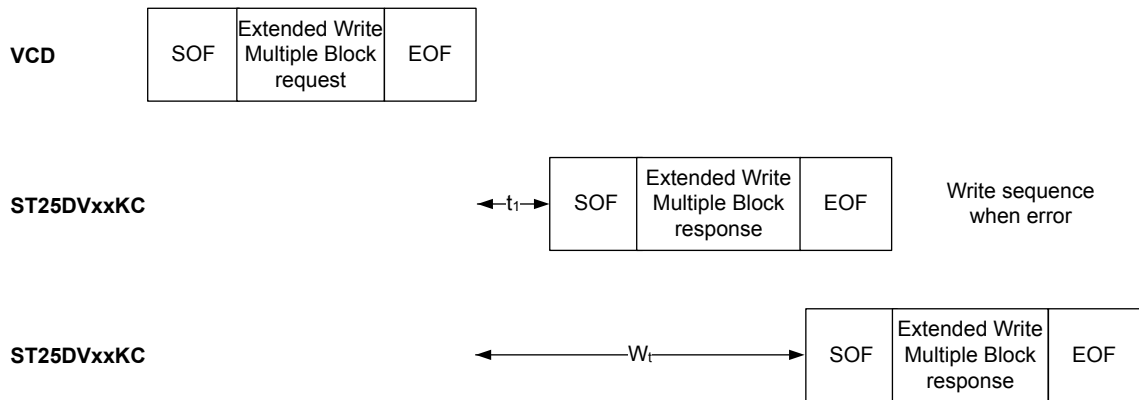
- No parameter. The response is sent back after the writing cycle.

**Table 141. 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 50. Extended Write Multiple Block frame exchange between VCD and**


### 7.6.16

#### Select

When receiving the Select command:

- If the UID is equal to its own UID, the ST25DVxxKC enters or stays in the Selected state and sends a response.
- If the UID does not match its own UID, the selected ST25DVxxKC returns to the Ready state and does not send a response.

The ST25DVxxKC 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 ST25DVxxKC remains in its current state.

The Option\_flag is not supported, and the Inventory\_flag must be set to 0.

**Table 142. Select request format**

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

Request parameter:

- UID

**Table 143. Select Block response format when Error\_flag is NOT set**

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

Response parameter:

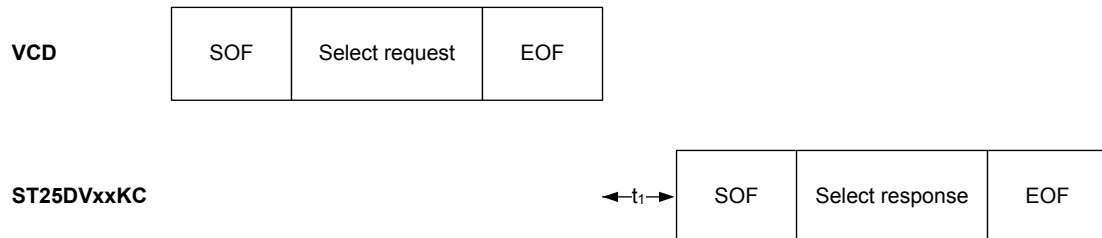
- No parameter

**Table 144. 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 51. Select frame exchange between VCD and ST25DVxxKC**

**7.6.17**
**Reset to Ready**

On receiving a Reset to Ready command, the ST25DVxxKC returns to the Ready state if no error occurs. In the Addressed mode, the ST25DVxxKC 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, and the Inventory\_flag must be set to 0.

**Table 145. Reset to Ready request format**

Request SOF	Request_flags	Reset to Ready	UID <sup>(1)</sup>	CRC16	Request EOF
-	8 bits	26h	64 bits	16 bits	-

1. This field is optional.

Request parameter:

- UID (optional)

**Table 146. Reset to Ready response format when Error\_flag is NOT set**

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

Response parameter:

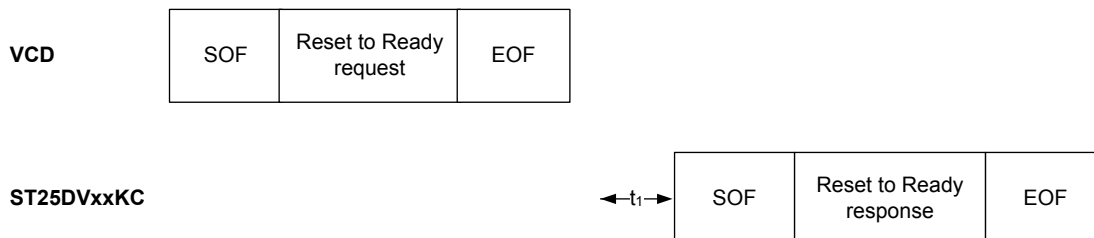
- No parameter

**Table 147. 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 52. Reset to Ready frame exchange between VCD and ST25DVxxKC**

**7.6.18**
**Write AFI**

On receiving the Write AFI request, the ST25DVxxKC programs the 8-bit AFI 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 ST25DVxxKC may not write correctly the AFI value into the memory. The  $W_t$  time is equal to  $t_{1nom} + N \times 302 \mu s$  (N is an integer).

**Table 148. Write AFI request format**

Request SOF	Request_flags	Write AFI	UID <sup>(1)</sup>	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 149. 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

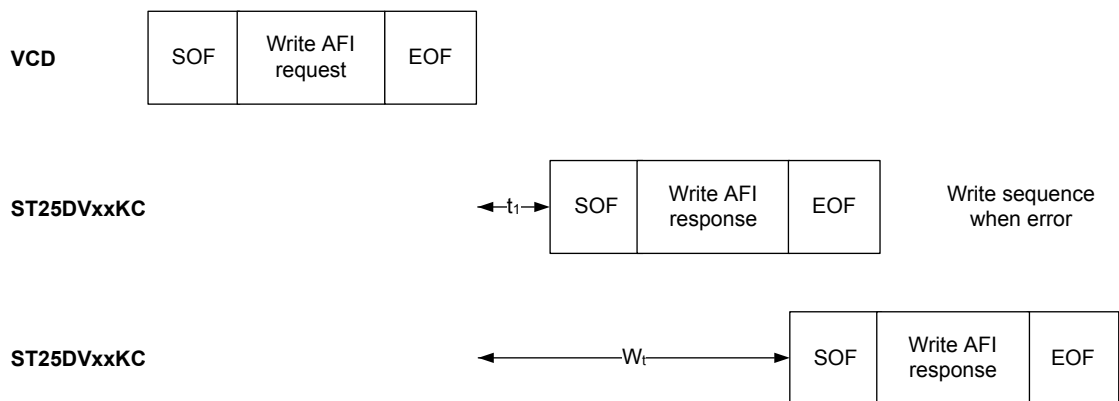
**Table 150. Write AFI response format when Error\_flag is set**

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 53. Write AFI frame exchange between VCD and ST25DVxxKC**



### 7.6.19 Lock AFI

On receiving the Lock AFI request, the ST25DVxxKC 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 ST25DVxxKC may not lock correctly the AFI value in memory. The  $W_t$  time is equal to  $t_{1nom} + N \times 302 \mu s$  (N is an integer).

**Table 151. Lock AFI request format**

Request SOF	Request_flags	Lock AFI	UID <sup>(1)</sup>	CRC16	Request EOF
-	8 bits	28h	64 bits	16 bits	-

1. This field is optional.

Request parameter:

- Request Flags
- UID (optional)

**Table 152. 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

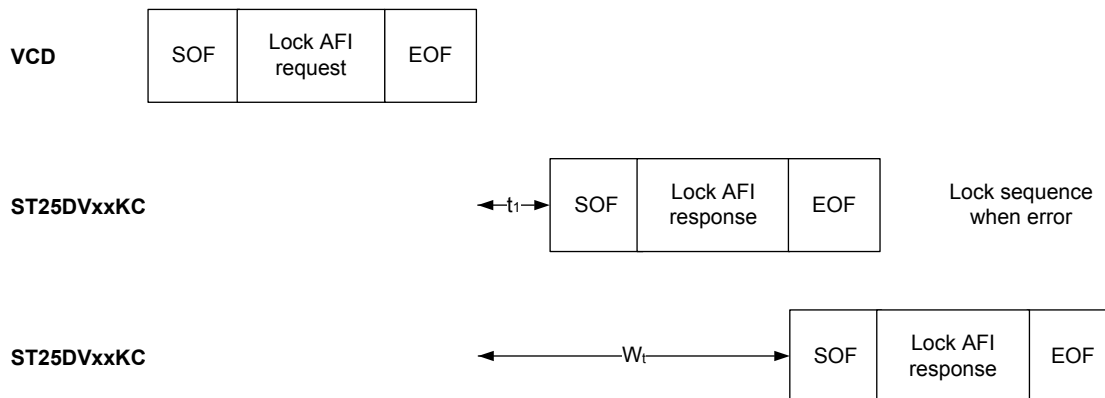


**Table 153. Lock AFI response format when Error\_flag is set**

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 54. Lock AFI frame exchange between VCD and ST25DVxxKC**


## 7.6.20

### Write DSFID

On receiving the Write DSFID request, the ST25DVxxKC 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 ST25DVxxKC may not write correctly the DSFID value in memory. The  $W_t$  time is equal to  $t_{1nom} + N \times 302 \mu s$  (N is an integer).

**Table 154. Write DSFID request format**

Request SOF	Request_flags	Write DSFID	UID <sup>(1)</sup>	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 155. Write DSFID response format when Error\_flag is NOT set**

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

Response parameter:

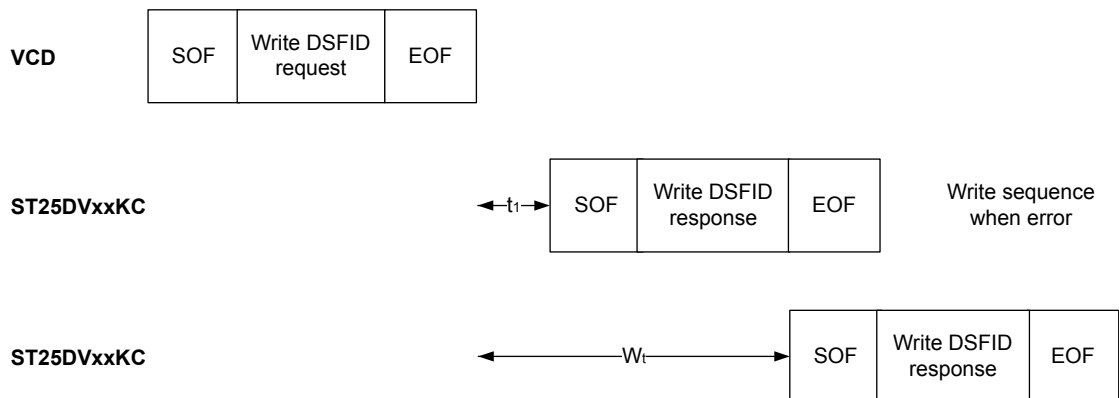
- No parameter

**Table 156. 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 55. Write DSFID frame exchange between VCD and ST25DVxxKC**


### 7.6.21

#### Lock DSFID

On receiving the Lock DSFID request, the ST25DVxxKC 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 ST25DVxxKC may not lock correctly the DSFID value in memory. The  $W_t$  time is equal to  $t_{1nom} + N \times 302 \mu s$  (N is an integer).

**Table 157. Lock DSFID request format**

Request SOF	Request_flags	Lock DSFID	UID <sup>(1)</sup>	CRC16	Request EOF
-	8 bits	2Ah	64 bits	16 bits	-

1. This field is optional.

Request parameter:

- Request flags
- UID (optional)

**Table 158. Lock DSFID response format when Error\_flag is NOT set**

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

Response parameter:

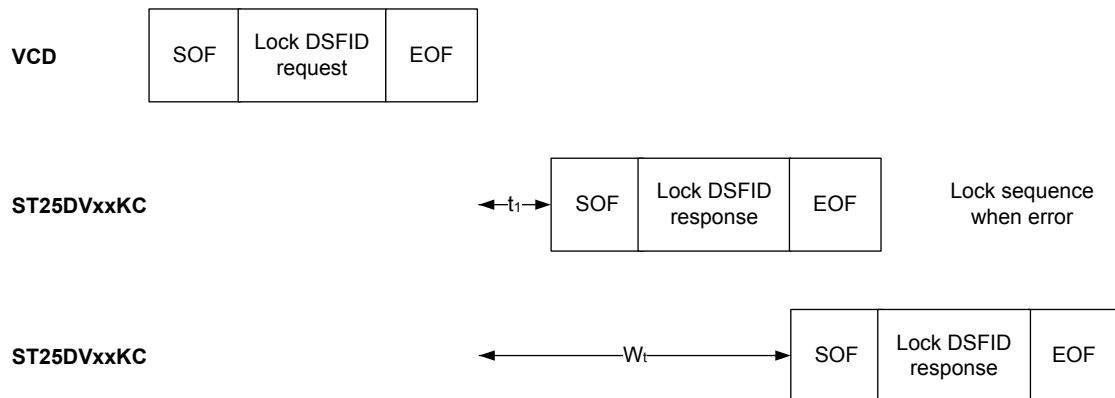
- No parameter.

**Table 159. 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 56. Lock DSFID frame exchange between VCD and ST25DVxxKC**


### 7.6.22 Get System Info

When receiving the Get System Info command, the ST25DVxxKC sends back its information data in the response.

The Option\_flag is not supported. The Inventory\_flag must be set to 0. The Get System Info can be issued in both Addressed and Non Addressed modes.

**Table 160. Get System Info request format**

Request SOF	Request_flags	Get System Info	UID <sup>(1)</sup>	CRC16	Request EOF
-	8 bits	2Bh	64 bits	16 bits	-

1. This field is optional.

Request parameter:

- Request flags
- UID (optional)

**Table 161. Get System Info response format Error\_flag is NOT set**

Device	Response SOF	Response flags	Information flags	UID	DSFID	AFI	Mem. Size	IC ref.	CRC16	Response EOF
ST25DV16KC	-	00h	0Bh	64 bits	8 bits	8 bits	NA <sup>(1)</sup>	51h	16 bits	-
ST25DV64KC			0Fh				037Fh	50h		
ST25DV04KC										

1. Field not present in this configuration

Response parameters:

- Information flags set to 0Bh/0Fh. DSFID, AFI and IC reference fields are present.
- UID code on 64 bits
- DSFID value
- AFI value
- MemSize: Block size in bytes and memory size in number of blocks (only present for ST25DV04KC configurations)

**Table 162. Memory size**

MSB			LSB		
16	14	13	9	8	1
RFU	Block size in byte			Number of blocks	
0h	03h			7Fh	

- ST25DVxxKC IC reference: the 8 bits are significant.

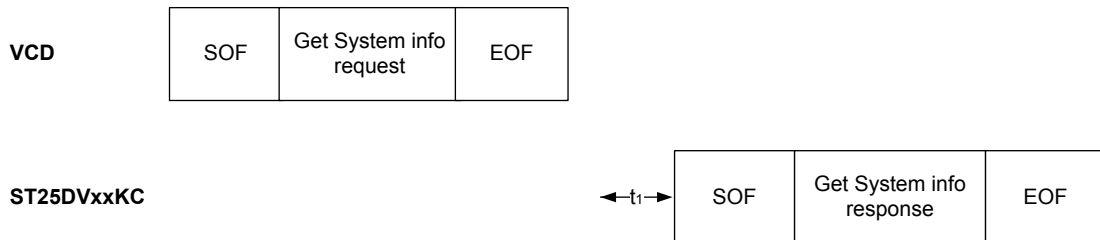
**Table 163. Get System Info response format when Error\_flag is set**

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 57. Get System Info frame exchange between VCD and ST25DVxxKC**



### 7.6.23 Extended Get System Info

When receiving the Extended Get System Info command, the ST25DVxxKC sends back its information data in the response.

The Option\_flag is not supported. The Inventory\_flag must be set to 0. The Extended Get System Info can be issued in both Addressed and Non Addressed modes.

**Table 164. Extended Get System Info request format**

Request SOF	Request_flags	Extended Get System Info	Parameter request field	UID <sup>(1)</sup>	CRC16	Request EOF
-	8 bits	0xx1xxxxb	8 bits	64 bits	16 bits	-

1. This field is optional.

- Request flags
- Request parameters
- UID (optional)

**Table 165. 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	VICC memory size	0	No request of data field on VICC memory size
		1	Request of data field on VICC 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	VICC Command list	0	No request of Data field of all supported commands
		1	Request of Data field of all supported commands
b7	CSI Information	0	No request of CSI list
		1	Request of CSI list
b8	Extended Get System Info parameter Field	0	One byte length of Extended Get System Info parameter field

**Table 166. Extended Get System Info response format when Error\_flag is NOT set**

Response SOF	Response_flags	Information flags	UID	DSFID <sup>(1) (2)</sup>	AFI <sup>(1) (2)</sup>	Other Field <sup>(1) (2)</sup>	CRC16	Response EOF
-	00h	8 bits <sup>(1)</sup>	64 bits	8 bits	8 bits	up to 64 bits <sup>(3)</sup>	16 bits	-

1. See [Table 167. Response Information Flag](#) .

2. This field is optional.

3. Number of bytes is function of parameter list selected.

Response parameters:

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

**Table 167. Response Information Flag**

Bit	Meaning if bit is set	Comment	
b1	DSFID	0	DSFID field is not present
		1	DSFID field is present
b2	AFI	0	AFI field is not present
		1	AFI field is present
b3	VICC memory size	0	Data field on VICC memory size is not present.
		1	Data field on VICC memory size is present.
b4	IC reference	0	Information on IC reference field is not present.
		1	Information on IC reference field is present
b5	MOI	0	1 byte addressing
		1	2 byte addressing
b6	VICC Command list	0	Data field of all supported commands is not present
		1	Data field of all supported commands is present
b7	CSI Information	0	CSI list is not present
b8	Info flag filed	0	One byte length of Info flag field

**Table 168. Response other field: ST25DVxxKC VICC memory size**

MSB		LSB	
24	22 21	17	16 01
RFU	Block size in byte		Number of blocks
0h	03h	007Fh (ST25DV04KC) 01FFh (ST25DV16KC) 07FFh (ST25DV64KC)	

**Table 169. Response other field: ST25DVxxKC IC Ref**

1 byte	
ICRef	
50h (ST25DV04KC)	
51h (ST25DV16KC)	
51h (ST25DV64KC)	

**Table 170. Response other field: ST25DVxxKC VICC command list**

MSB				LSB			
32	25	24	17	16	09	08	01
Byte 4		Byte3		Byte 2		Byte 1	
00h		3Fh		3Fh		FFh	

**Table 171. Response other field: ST25DVxxKC VICC command list Byte 1**

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

**Table 172. Response other field: ST25DVxxKC VICC command list Byte 2**

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

**Table 173. Response other field: ST25DVxxKC VICC command list Byte 3**

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



**Table 174. Response other field: ST25DVxxKC VICC command list Byte 4**

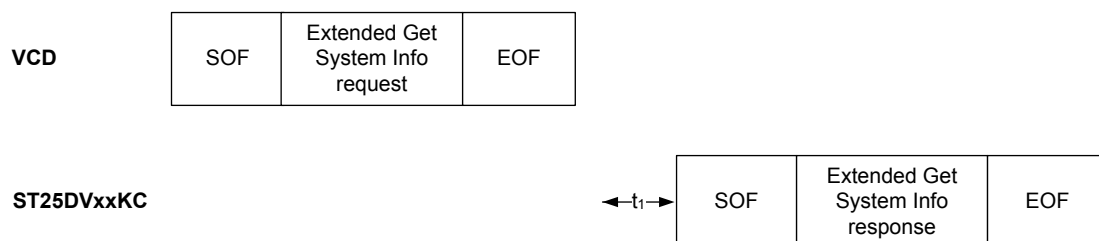
Bit	Meaning if bit is set	Comment
b1	Read Buffer is supported	It means Response Buffer is supported.
b2	Select Secure State is supported	It means VCD or Mutual authentication are supported.
b3	Final Response always includes crypto result	It means that flag b3 is set in the Final response.
b4	AuthComm 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 must be returned.

**Table 175. 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 58. Extended Get System Info frame exchange between VCD and ST25DVxxKC**


### 7.6.24 Get Multiple Block Security Status

When receiving the Get Multiple Block Security Status command, the 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, returns the security status of seven blocks. This command does not respond an error if number of blocks overlap areas or overlap the end of the user memory.

The number of blocks is coded on 1 Byte and only first 256 blocks of ST25DV16KC and ST25DV64KC can be addressed using this command.

The Option\_flag is not supported. The Inventory\_flag must be set to 0.

**Table 176. Get Multiple Block Security Status request format**

Request SOF	Request_flags	Get Multiple Block Security Status	UID <sup>(1)</sup>	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 177. 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 <sup>(1)</sup>	16 bits	-

1. Repeated as needed.

Response parameters:

- Block security status

**Table 178. Block security status**

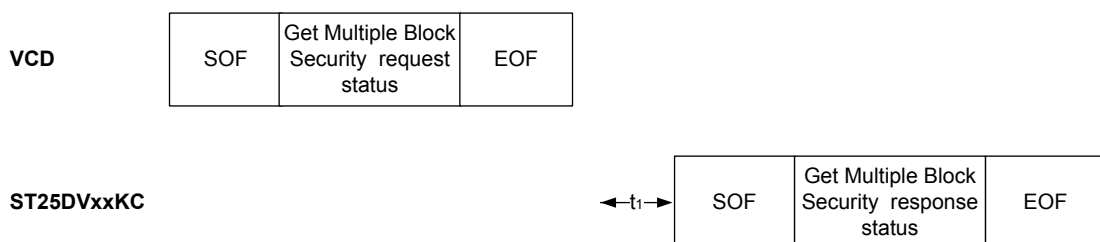
b <sub>7</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	b <sub>0</sub>
Reserved for future use							0: Current block not locked
All at 0							1: Current block locked

**Table 179. 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 59. Get Multiple Block Security Status frame exchange between VCD and**


### 7.6.25 Extended Get Multiple Block Security Status

When receiving the Extended Get Multiple Block Security Status command, the ST25DVxxKC 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 overlap the end of the user memory.

The number of blocks is coded on 2 Bytes so all memory blocks of ST25DV16KC and ST25DV64KC can be addressed using this command.

The Option\_flag is not supported. The Inventory\_flag must be set to 0.

**Table 180. Extended Get Multiple Block Security Status request format**

Request SOF	Request_flags	Extended Get Multiple Block Security Status	UID <sup>(1)</sup>	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 181. 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 <sup>(1)</sup>	16 bits	-

1. Repeated as needed.

Response parameters:

- Block security status

**Table 182. Block security status**

b <sub>7</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	b <sub>0</sub>
Reserved for future use All at 0							0: Current block not locked 1: Current block locked

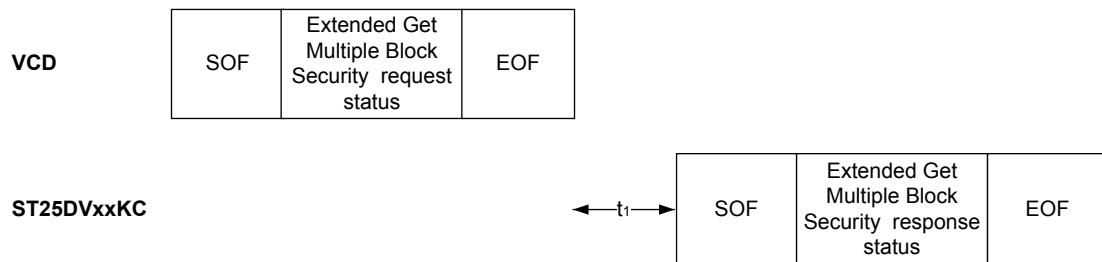
**Table 183. Extended Get Multiple Block Security Status response format when Error\_flag is set**

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 60. Extended Get Multiple Block Security Status frame exchange between VCD and ST25DVxxKC**



**7.6.26 Read Configuration**

On receiving the Read Configuration command, the ST25DVxxKC 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 184. Read Configuration request format**

Request SOF	Request_flags	Read Configuration	IC Mfg code	UID <sup>(1)</sup>	Pointer	CRC16	Request EOF
-	8 bits	A0h	02h	64 bits	8 bits	16 bits	-

1. This field is optional.

*Note:* Please refer to [Table 13. System configuration memory map](#) for details on register addresses.

Request parameters:

- System configuration register pointer
- UID (optional)

**Table 185. 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:

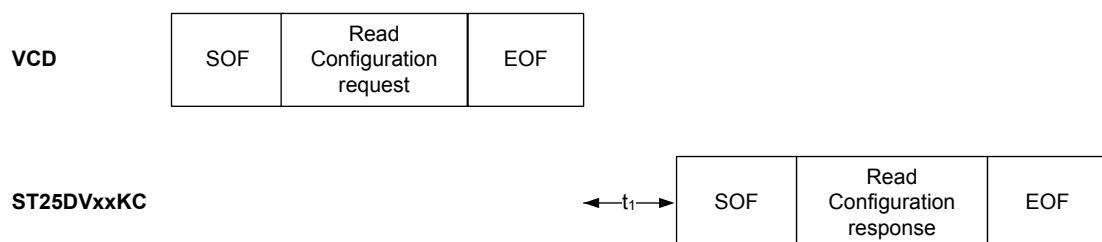
- One byte of data: system configuration register

**Table 186. 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 61. Read Configuration frame exchange between VCD and ST25DVxxKC**


### 7.6.27 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 ST25DVxxKC 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 ST25DVxxKC may not program correctly the data into the Configuration byte. The  $W_t$  time is equal to  $t_{1nom} + N \times 302 \mu s$  (N is an integer).

**Table 187. Write Configuration request format**

Request SOF	Request_flags	Write Configuration	IC Mfg code	UID <sup>(1)</sup>	Pointer	Register value <sup>(2)</sup>	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 188. 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 13. System configuration memory map](#) for details on register addresses.

Response parameter:

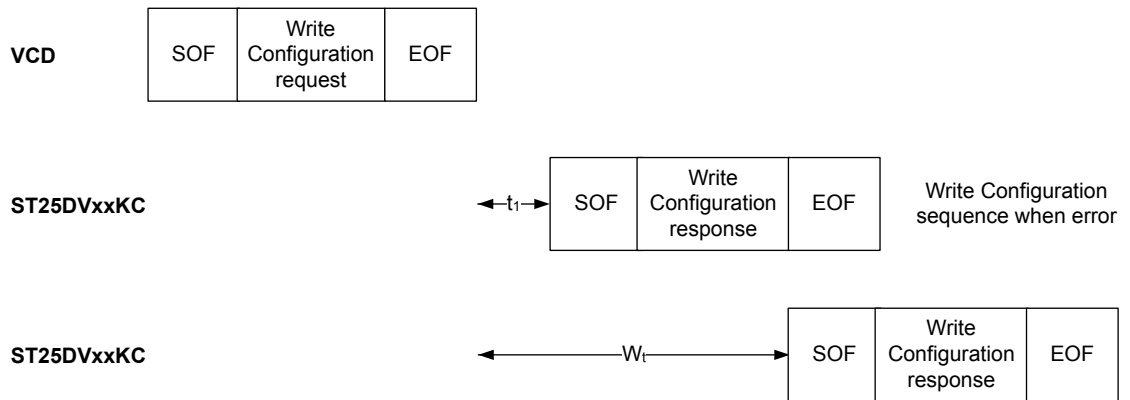
- No parameter. The response is sent back after the writing cycle.

**Table 189. 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 62. Write Configuration exchange between VCD and ST25DVxxKC**


### 7.6.28 Read Dynamic Configuration

On receiving the Read Dynamic Configuration command, the ST25DVxxKC reads the Dynamic register address indicated by the pointer 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 190. Read Dynamic Configuration request format**

Request SOF	Request_flags	Read Dynamic Configuration	IC Mfg code	UID <sup>(1)</sup>	Pointer address	CRC16	Request EOF
-	8 bits	ADh	02h	64 bits	8 bits	16 bits	-

1. This field is optional.

Request parameters:

- UID (Optional)

**Table 191. Read Dynamic Configuration response format when Error\_flag is NOT set**

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

Response parameters:

- One byte of data

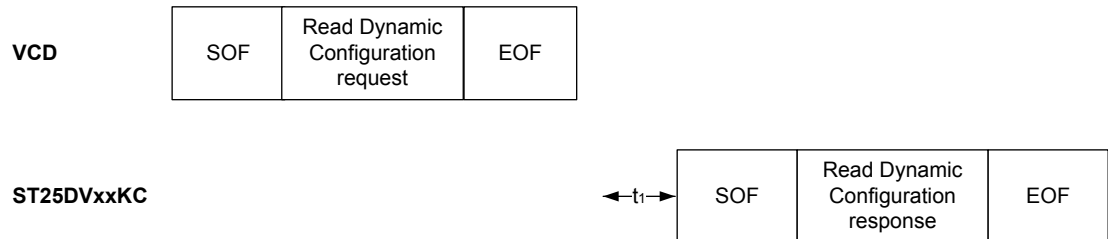
*Note:* Please refer to [Table 13. System configuration memory map](#) for details on register addresses.

**Table 192. Read Dynamic 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 not supported
  - 0Fh: error given with no information
  - 10h: block not available

**Figure 63. Read Dynamic Configuration frame exchange between VCD and ST25DVxxKC**


### 7.6.29 Write Dynamic Configuration

On receiving the Write Dynamic Configuration command, the ST25DVxxKC updates the Dynamic register addressed by the pointer.

The Option\_flag is not supported. The Inventory\_flag must be set to 0.

**Table 193. Write Dynamic Configuration request format**

Request SOF	Request_flags	Write Dynamic Configuration	IC Mfg code	UID <sup>(1)</sup>	Pointer address	Register value	CRC16	Request EOF
-	8 bits	A Eh	02h	64 bits	8 bits	8 bits	16 bits	-

1. This field is optional.

Request parameters:

- Request flags
- UID (Optional)
- Pointer address
- Register value

**Table 194. Write Dynamic Configuration response format when Error\_flag is NOT set**

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

Response parameters:

- No parameter. The response is sent back after  $t_1$ .

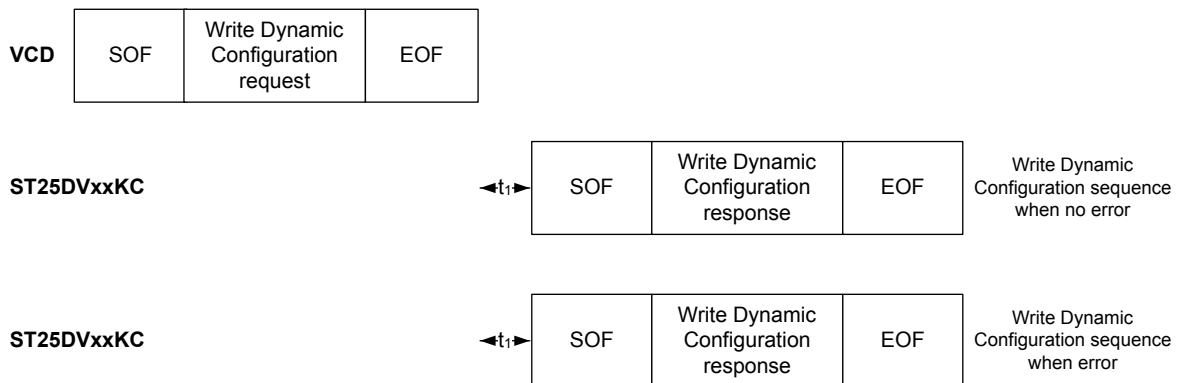
**Table 195. Write Dynamic Configuration response format when Error\_flag is set**

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 not supported
  - 0Fh: error with no information given
  - 10h: block not available



**Figure 64. Write Dynamic Configuration frame exchange between VCD and ST25DVxxKC**


### 7.6.30 Manage GPO

On receiving the Manage GPO command. Depending on the command argument, the ST25DVxxKC force the GPO output level if RF\_USER interrupt is enabled, or send a pulse on GPO output if RF\_INTERRUPT is enabled. If neither RF\_USER nor RF\_INTERRUPT was enabled, the command is not executed and ST25DVxxKC responds an Error code "0F".

The IT duration is defined by IT\_TIME bits 4 to 2 of GPO2 static register and occurs just after the command response.

For the 12- pin package ST25DVxxKC version (CMOS GPO output):

- Set means that the GPO pin is driven to a High level (VDCG).
- Reset pulls the GPO pin to a low level (VSS).
- The IT corresponds to a transmission of a positive pulse on the GPO pin.

For the 12 pin package ST25DVxxKC version (open drain GPO output):

- Set means that the GPO pin is driven to a low level (VSS).
- Reset releases the GPO (High impedance). Thanks to an external pull-up, the high level is recovered.
- IT corresponds to the GPO pin driven to ground during the IT duration, then pin is released.

Option\_flag is not supported. The Inventory\_flag must be set to 0.

**Table 196. Manage GPO request format**

Request SOF	Request_flags	Manage GPO	IC Mfg code	UID <sup>(1)</sup>	GPO VAL <sup>(2)</sup>	CRC16	Request EOF
-	8 bits	A9h	02h	64 bits	8 bits	16 bits	-

1. This field is optional.

2. See Table 197. GPOVAL

**Table 197. GPOVAL**

GPOVAL	IT	GPO pin output
0xxxxx0b	RF_USER enabled	Pin pull to 0
0xxxxx1b	RF_USER enabled	Pin released (HZ)
1xxxxxxb	RF_INTERRUPT enabled	GPO pin pulled to 0 during IT Time then released (HZ)
Any other conditions		GPO released (Hz)

Request parameters:

- Request flag
- UID (optional)
- Data: Define static or dynamic Interrupt

**Table 198. Manage GPO 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.

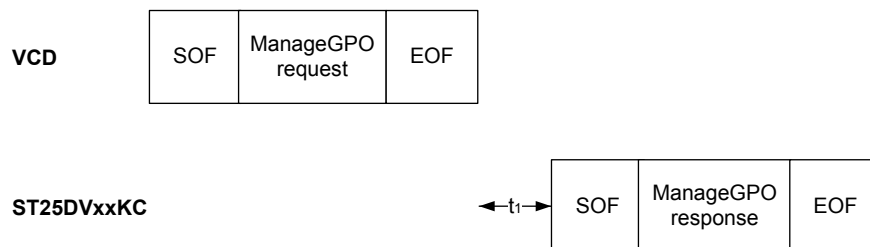
**Table 199. ManageGPO response format when Error\_flag is set**

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
  - 13h: the specified block was not successfully programmed (this error is generated if the ManageGPO GPOVAL value is not in line with the GPO interrupts setting as specified in Table 197. GPOVAL)

**Figure 65. Manage GPO frame exchange between VCD and ST25DVxxKC**



### 7.6.31

#### Write Message

On receiving the Write Message command, the ST25DVxxKC puts the data contained in the request into the Mailbox buffer, update the MB\_LEN\_Dyn register, and set bit RF\_PUT\_MSG in MB\_CTRL\_Dyn register. It then reports if the write operation was successful in the response. The ST25DVxxKC Mailbox contains up to 256 data bytes which are filled from the first location '00'. MSGLength parameter of the command is the number of Data bytes minus - 1 (00 for 1 byte of data, FFh for 256 bytes of data). Write Message could be executed only when Mailbox is accessible by RF (fast transfer mode is enabled, previous RF message was read or time-out occurs, no I<sup>2</sup>C message to be read). User can check it by reading b1 of MB\_CTRL\_Dyn "HOST\_PUT\_MSG" which must be reset to "0". The Option\_flag is not supported. (refer to Section 5.1 Fast transfer mode (FTM)).

**Table 200. Write Message request format**

Request SOF	Request_flags	Write Message	IC Mfg code	UID <sup>(1)</sup>	MSGLength	Message Data	CRC16	Request EOF
-	8 bits	AAh	02h	64 bits	1 byte	(MSGLength + 1) bytes	16 bits	-

1. This field is optional.

Request parameters:

- Request flags
- UID (optional)
- Message Length
- Message Data

**Table 201. Write Message 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.

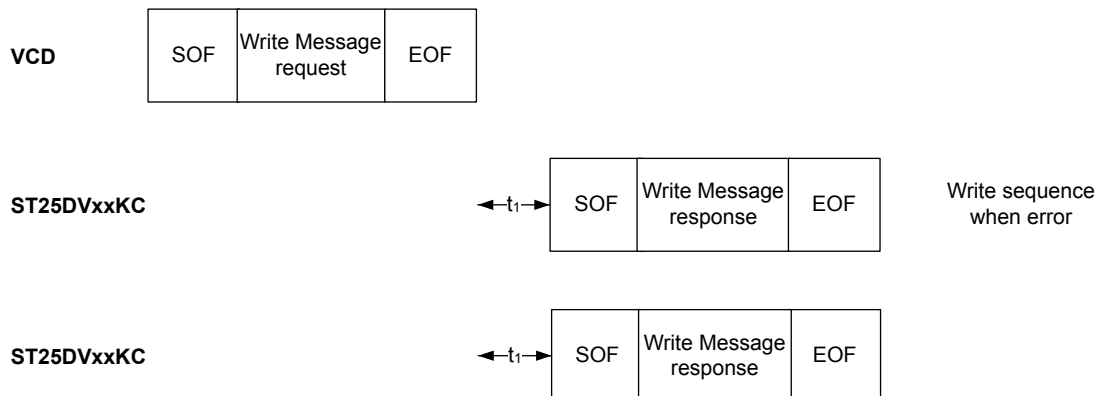
**Table 202. Write Message response format when Error\_flag is set**

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

**Figure 66. Write Message frame exchange between VCD and ST25DVxxKC**



### 7.6.32 Read Message Length

On receiving the Read Message Length command, the ST25DVxxKC reads the MB\_LEN\_Dyn register which contains the Mailbox message length and sends back its 8-bit value in the response.

The value of MB\_LEN\_Dyn returned is the (size of the message length in Bytes - 1).

The Option\_flag is not supported. The Inventory\_flag must be set to 0.

**Table 203. Read Message Length request format**

Request SOF	Request_flags	Read Message Length	IC Mfg code	UID <sup>(1)</sup>	CRC16	Request EOF
-	8 bits	ABh	02h	64 bits	16 bits	-

1. The field is optional.

Request parameters:

- UID (Optional)

**Table 204. Read Message Length response format when Error\_flag is NOT set**

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

Response parameters:

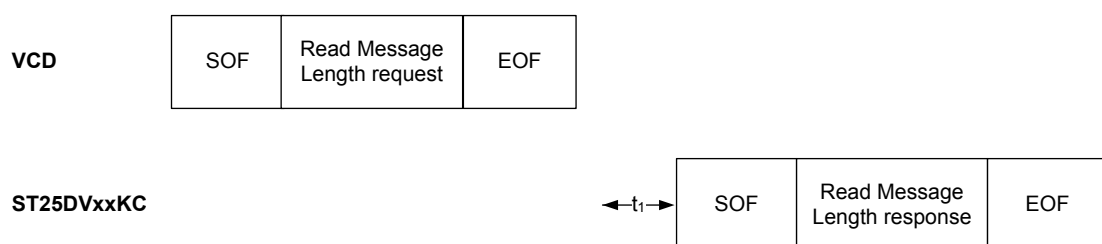
- One byte of data: MB\_LEN\_Dyn register value

**Table 205. Read Message Length 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 given with no information

**Figure 67. Read Message Length frame exchange between VCD and ST25DVxxKC**


### 7.6.33

#### Read Message

On receiving the Read Message command, the ST25DVxxKC reads up to 256 byte in the Mailbox from the location specified by MBpointer and sends back their value in the response. First MailBox location is '00'. When Number of bytes is set to 00h and MBPointer is equals to 00h, the MB\_LEN bytes of the full message are returned. Otherwise, Read Message command returns (Number of Bytes + 1) bytes (i.e. 01h returns 2 bytes, FFh returns 256 bytes).

An error is reported if (Pointer + Nb of bytes + 1) is greater than the message length. RF Reading of the last byte of the mailbox message automatically clears b1 of MB\_CTRL\_Dyn "HOST\_PUT\_MSG", and allows RF to put a new message.

The Option\_flag is not supported. The Inventory\_flag must be set to 0.

**Table 206. Read Message request format**

Request SOF	Request_flags	Read Message	IC Mfg code	UID <sup>(1)</sup>	MBpointer	Number of Bytes	CRC16	Request EOF
-	8 bits	ACh	02h	64 bits	8 bits	8 bits	16 bits	-

1. This field is optional.

Request parameters:

- Request flag
- UID (Optional)
- Pointer (start at 00h)
- Number of bytes is one less then the requested data

**Table 207. Read Message response format when Error\_flag is NOT set**

Response SOF	Response_flags	Mailbox content	CRC16	Response EOF
-	8 bits	(Number of bytes + 1) bytes <sup>(1)</sup>	16 bits	-

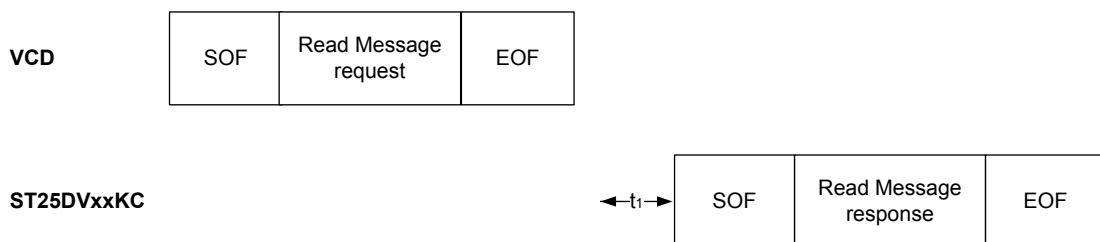
1. Number of message Bytes when Number of Bytes is set to 00h.

Response parameters:

- (number of data + 1 ) data bytes

Response parameter:

- Error code as Error\_flag is set:
  - 02h: command not recognized
  - 03h: command option not supported
  - 0Fh: error with no information given

**Figure 68. Read Message frame exchange between VCD and ST25DVxxKC**


### 7.6.34 Fast Read Message

On receiving the Fast Read Message command, the ST25DVxxKC reads up to 256 byte in the Mailbox from the location specified by MBpointer and sends back their value in the response. First MailBox location is '00'. When Number of bytes is set to 00h and MBPointer is equals to 00h, the MB\_LEN bytes of the full message are returned. Otherwise, Fast Read Message command returns (Number of Bytes + 1) bytes (i.e. 01h returns 2 bytes, FFh returns 256 bytes).

An error is reported if (Pointer + Nb of bytes + 1) is greater than the message length..

RF Reading of the last byte of mailbox message automatically clears b1 of MB\_CTRL\_Dyn "HOST\_PUT\_MSG" and allows RF to put a new message.

The data rate of the response is multiplied by 2 compared to Read Message.

The subcarrier\_flag should be set to 0, otherwise the ST25DVxxKC answers with an error code. The Option\_flag is not supported, and the Inventory\_flag must be set to 0.

**Table 208. Fast Read Message request format**

Request SOF	Request_flags	Fast Read Message	IC Mfg code	UID <sup>(1)</sup>	MBpointer	Number of Bytes	CRC16	Request EOF
-	8 bits	CCh	02h	64 bits	8 bits	8 bits	16 bits	-

1. This field is optional

Request parameters:

- Request flag
- UID (Optional)
- Pointer (start at 00h)
- Number of bytes is one less than the requested data

**Table 209. Fast Read Message response format when Error\_flag is NOT set**

Response SOF	Response_flags	Mailbox content	CRC16	Response EOF
-	8 bits	(Number of bytes + 1) bytes <sup>(1)</sup>	16 bits	64 bits

1. Number of message Bytes when Number of Bytes is set to 00h

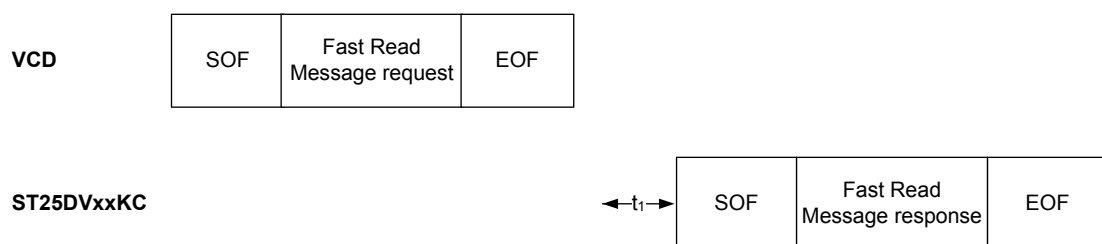
Response parameters:

- (number of bytes + 1) data bytes

Response parameter:

- Error code as Error\_flag is set:
  - 02h: command not recognized
  - 03h: command option not supported
  - 0Fh: error with no information given

**Figure 69. Fast Read Message frame exchange between VCD and ST25DVxxKC**



### 7.6.35 Write Password

On receiving the Write Password command, the ST25DVxxKC uses the data contained in the request to write the password and reports whether the operation was successful in the response. It is possible to modify a Password value only after issuing a valid Present password command (of the same password number). When the Option\_flag is set, wait for EOF to respond. Refer to [Section 5.6 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 ST25DVxxKC may not correctly program the data into the memory.

The  $W_t$  time is equal to  $t_{1nom} + N \times 302 \mu s$  ( $N$  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 ST25DVxxKC power-down.

**Caution:** If ST25DVxxKC is powered through  $V_{CC}$ , removing  $V_{CC}$  during Write Password command can abort the command. As a consequence, before writing a new password, RF user should check if  $V_{CC}$  is ON, by reading EH\_CTRL\_Dyn register bit 3 (VCC\_ON), and eventually ask host to maintain or to shut down  $V_{CC}$ , during the Write Password command in order to avoid password corruption.

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 210. Write Password request format**

Request SOF	Request_flags	Write password	IC Mfg code	UID <sup>(1)</sup>	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 = RF configuration password RF\_PWD\_0,
  - 01h = RF\_PWD\_1,
  - 02h = RF\_PWD\_2,
  - 03h = RF\_PWD\_3,
  - other = Error
- Data

**Table 211. Write Password response format when Error\_flag is NOT set**

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

Response parameter:

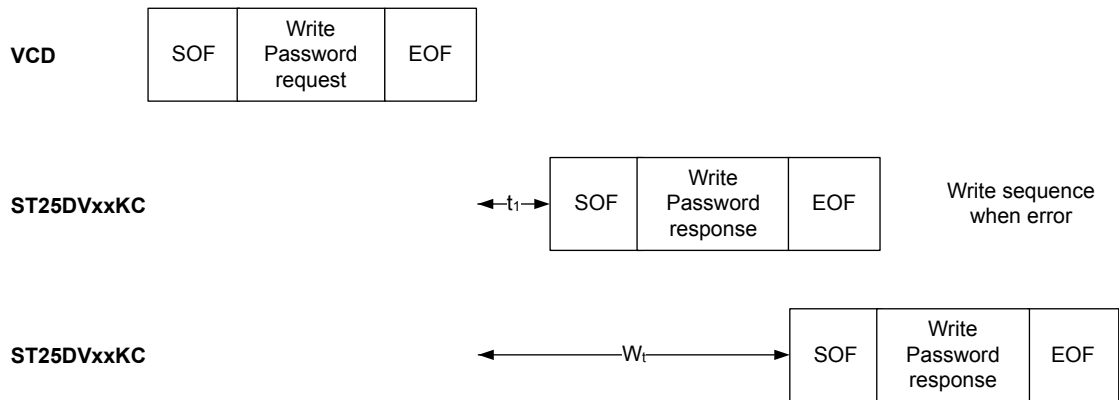
- no parameter.

**Table 212. 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 70. Write Password frame exchange between VCD and ST25DVxxKC**

**7.6.36**
**Present Password**

On receiving the Present Password command, the ST25DVxxKC compares the requested password with the data contained in the request and reports if the operation has been successful in the response. Refer to [Section 5.6 Data protection](#) for details on password Management. After a successful command, the security session associate to the password is open as described in [Section 5.6 Data protection](#).

The Option\_flag is not supported, and the Inventory\_flag must be set to 0.

**Table 213. Present Password request format**

Request SOF	Request_flags	Present Password	IC Mfg code	UID <sup>(1)</sup>	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 = RF configuration password RF\_PWD\_0
  - 01h = RF\_PWD\_1
  - 02h = RF\_PWD\_2
  - 03h = RF\_PWD\_3
  - other = Error
- Password

**Table 214. 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.

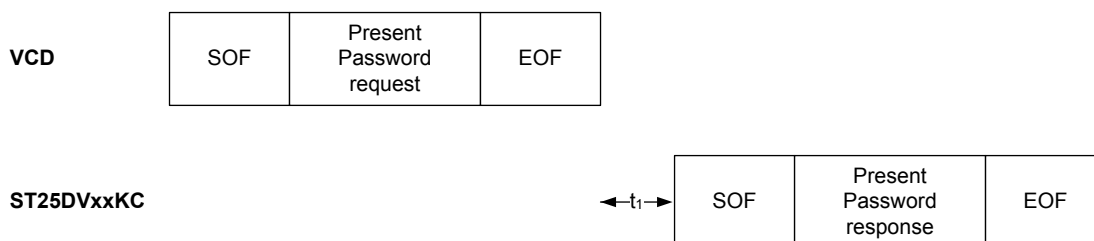


**Table 215. Present Password response format when Error\_flag is set**

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 71. Present Password frame exchange between VCD and ST25DVxxKC**


### 7.6.37

#### Fast Read Single Block

On receiving the Fast Read Single Block command, the ST25DVxxKC 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 ST25DVxxKC 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 ST25DV16KC and ST25DV64KC can be addressed using this command.

**Table 216. Fast Read Single Block request format**

Request SOF	Request_flags	Fast Read Single Block	IC Mfg code	UID <sup>(1)</sup>	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 217. Fast Read Single Block response format when Error\_flag is NOT set**

Response SOF	Response_flags	Block security status <sup>(1)</sup>	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 218)
- Four bytes of block data

**Table 218. Block security status**

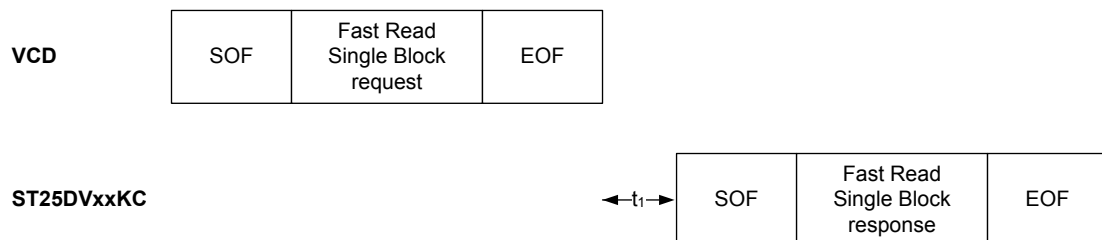
b <sub>7</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	b <sub>0</sub>
Reserved for future use All at 0							0: Current Block not locked 1: Current Block locked

**Table 219. 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 72. Fast Read Single Block frame exchange between VCD and ST25DVxxKC**


### 7.6.38 Fast Extended Read Single Block

On receiving the Fast Extended Read Single Block command, the ST25DVxxKC 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 ST25DVxxKC 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 ST25DV16KC and ST25DV64KC can be addressed using this command

**Table 220. Fast Extended Read Single Block request format**

Request SOF	Request_flags	Fast Extended Read Single Block	IC Mfg code	UID <sup>(1)</sup>	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 221. Fast Extended Read Single Block response format when Error\_flag is NOT set**

Response SOF	Response_flags	Block security status <sup>(1)</sup>	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 the table below)
- Four bytes of block data

**Table 222. Block security status**

b <sub>7</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	b <sub>0</sub>
Reserved for future use All at 0							0: Current Block not locked 1: Current Block locked

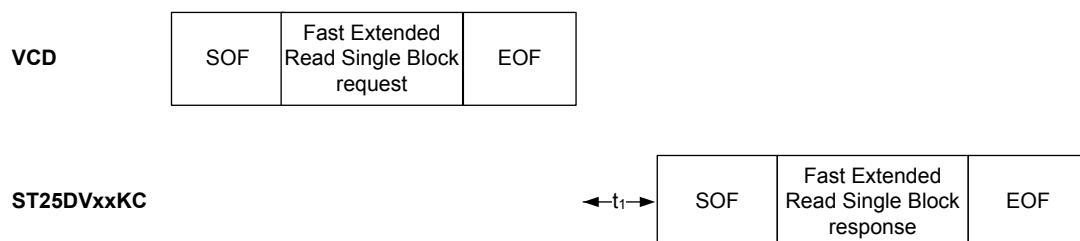
**Table 223. Fast Extended Read Single Block response format when Error\_flag is set**

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 73. Fast Extended Read Single Block frame exchange between VCD and ST25DVxxKC**



### 7.6.39 Fast Read Multiple Blocks

On receiving the Fast Read Multiple Blocks command, the ST25DVxxKC 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).

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 ST25DVxxKC 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 ST25DV16KC and ST25DV64KC can be addressed using this command.

**Table 224. Fast Read Multiple Block request format**

Request SOF	Request_flags	Fast Read Multiple Block	IC Mfg code	UID <sup>(1)</sup>	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
- Number of blocks

**Table 225. Fast Read Multiple Block response format when Error\_flag is NOT set**

Response SOF	Response_flags	Block security status <sup>(1)</sup>	Data	CRC16	Response EOF
-	8 bits	8 bits <sup>(2)</sup>	32 bits <sup>(2)</sup>	16 bits	-

1. This field is optional.

2. Repeated as needed.

Response parameters:

- Block security status if Option\_flag is set (see Table 226)
- N block of data

**Table 226. Block security status if Option\_flag is set**

b <sub>7</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	b <sub>0</sub>
Reserved for future use All at 0							0: Current not locked 1: Current locked

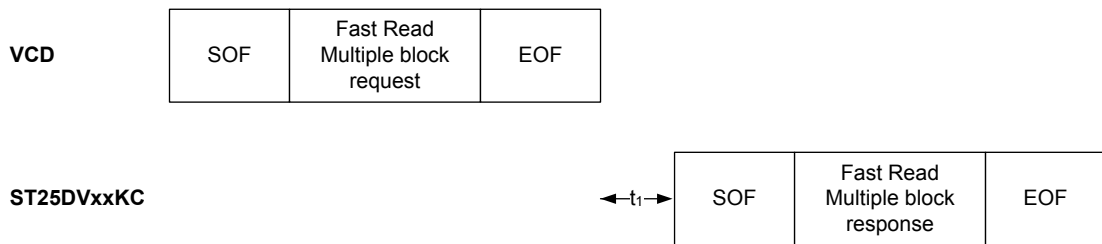
**Table 227. Fast Read Multiple Block response format when Error\_flag is set**

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 74. Fast Read Multiple Block frame exchange between VCD and ST25DVxxKC**



#### 7.6.40

#### Fast Extended Read Multiple Block

On receiving the Fast Extended Read Multiple Block command, the ST25DVxxKC 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 ST25DVxxKC 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 ST25DV16KC and ST25DV64KC can be addressed using this command.

**Table 228. Fast Extended Read Multiple Block request format**

Request SOF	Request_flags	Fast Extended Read Multiple Block	IC Mfg code	UID <sup>(1)</sup>	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 229. Fast Extended Read Multiple Block response format when Error\_flag is NOT set**

Response SOF	Response_flags	Block security status <sup>(1)</sup>	Data	CRC16	Response EOF
-	8 bits	8 bits <sup>(2)</sup>	32 bits <sup>(2)</sup>	16 bits	-

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

Response parameters:

- Block security status if Option\_flag is set (see Table 230)
- N block of data

**Table 230. Block security status if Option\_flag is set**

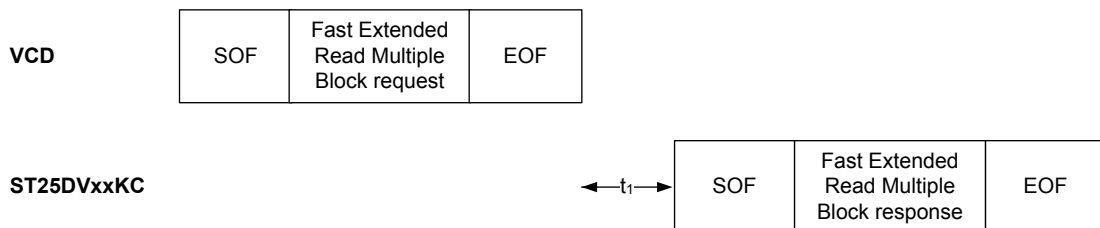
b <sub>7</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	b <sub>0</sub>
Reserved for future use All at 0							0: Current not locked 1: Current locked

**Table 231. 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 75. Fast Extended Read Multiple Block frame exchange between VCD and ST25DVxxKC**


### 7.6.41 Fast Write Message

On receiving the Fast Write Message command, the ST25DVxxKC puts the data contained in the request into the mailbox buffer, updates the Message Length register MB\_LEN\_Dyn, and set Mailbox loaded bit RF\_PUT\_MSG. It then reports if the write operation was successful in the response. The ST25DVxxKC mailbox contains up to 256 data bytes which are filled from the first location '00'. MSGlength parameter of the command is the number of Data bytes minus - 1 (00 for 1 byte of data, FFh for 256 bytes of data). Fast Write Message can be executed only when Mailbox is accessible by RF (previous RF message was read or time-out occurs, no I<sup>2</sup>C message to be read). User can check it by reading b1 of MB\_CTRL\_Dyn "HOST\_PUT\_MSG", which must be reset to "0". (refer to Section 5.1 Fast transfer mode (FTM)).

- The data rate of the response is multiplied by 2 compared to Write Message command.

- The Option\_flag is not supported.
- The Inventory\_flag must be set to 0.
- The subcarrier\_flag should be set to 0, otherwise the ST25DVxxKC answers with an error code.

**Table 232. Fast Write Message request format**

Request SOF	Request_flags	Fast Write Message	IC Mfg code	UID <sup>(1)</sup>	MSGLength	Message Data	CRC16	Request EOF
-	8 bits	CAh	02h	64 bits	1 byte	(MsgLenght + 1) bytes	16 bits	-

1. This field is optional.

Request parameters:

- Request flag
- UID (optional)
- Message Lenght
- Message Data

**Table 233. Fast Write Message response format when Error\_flag is NOT set**

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

Response parameters:

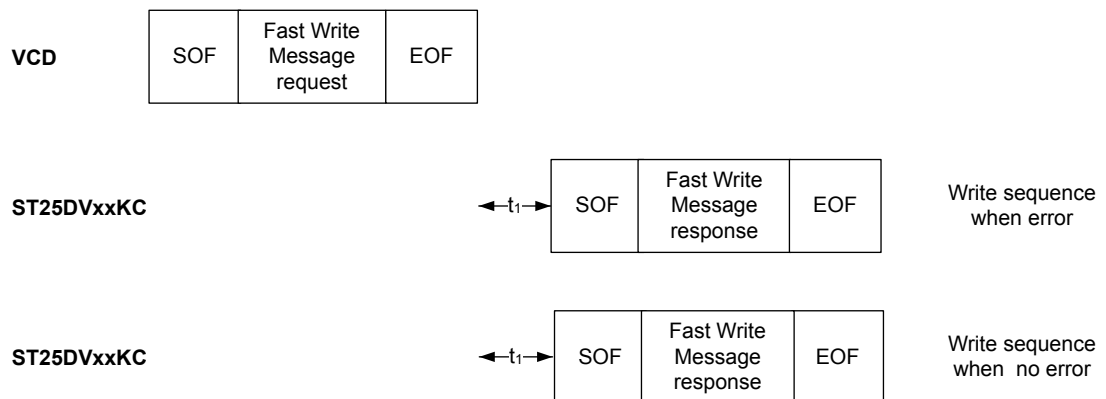
- No parameter. The response is sent back after the write cycle.

**Table 234. Fast Write Message 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

**Figure 76. Fast Write Message frame exchange between VCD and ST25DVxxKC**


### 7.6.42 Fast Read Message Length

On receiving the Fast Read Message Length command, the ST25DVxxKC reads the MB\_LEN\_dyn register which contains the mailbox message length and sends back its 8-bit value in the response.

The value of MB\_LEN\_Dyn returned is the (size of the message length in Bytes - 1).

The Option\_flag is not supported. The Inventory\_flag must be set to 0.

The subcarrier\_flag should be set to 0, otherwise the ST25DVxxKC answers with an error code.

The data rate of the response is multiplied by 2 compared to Read Message Length command.

**Table 235. Fast Read Message Length request format**

Request SOF	Request_flags	Fast Read Message Length	IC Mfg code	UID <sup>(1)</sup>	CRC16	Request EOF
-	8 bits	CBh	02h	64 bits	16 bits	-

1. This field is optional.

Request parameters:

- Request flag
- UID (optional)

**Table 236. Fast Read Message Length response format when Error\_flag is NOT set**

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

Response parameters:

- One byte of data: volatile Control register.

**Table 237. Fast Read Message Length response format when Error\_flag is set**

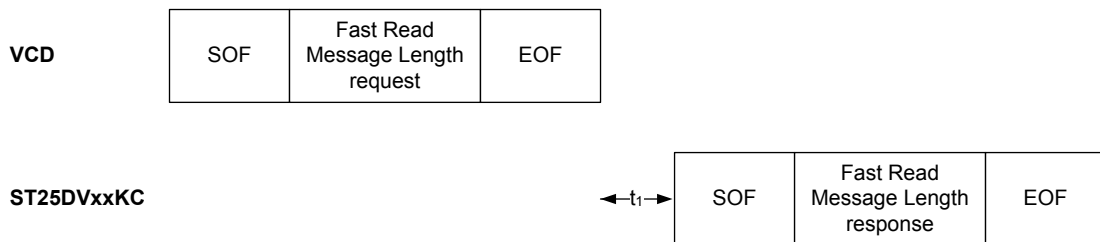
Response SOF	Response_flags	Error code	CRC16	Response EOF
-	8 bits	8 bits	16 bits	-



Response parameter:

- Error code as Error\_flag is set:
  - 02h: command option not recognized
  - 03h: command not supported
  - 0Fh: error with no information given

**Figure 77. Fast Read Message Length frame exchange between VCD and ST25DVxxKC**



### 7.6.43 Fast Read Dynamic configuration

On receiving the Fast Read Dynamic configuration command, the ST25DVxxKC reads the Dynamic register address by the pointer and sends back its 8-bit value in the response.

The Option\_flag is not supported. The Inventory\_flag must be set to 0.

The subcarrier\_flag should be set to 0, otherwise the ST25DVxxKC answers with an error code.

The data rate of the response is multiplied by 2 compared to Read Dynamic configuration command.

**Table 238. Fast Read Dynamic configuration request format**

Request SOF	Request_flags	Fast Read Dynamic configuration	IC Mfg code	UID <sup>(1)</sup>	Pointer address	CRC16	Request EOF
-	8 bits	CDh	02h	64 bits	8 bits	16 bits	-

1. This field is optional.

Request parameters:

- Request flag
- UID (optional)

**Table 239. Fast Read Dynamic configuration response format when Error\_flag is NOT set**

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

Response parameters:

- One byte of data

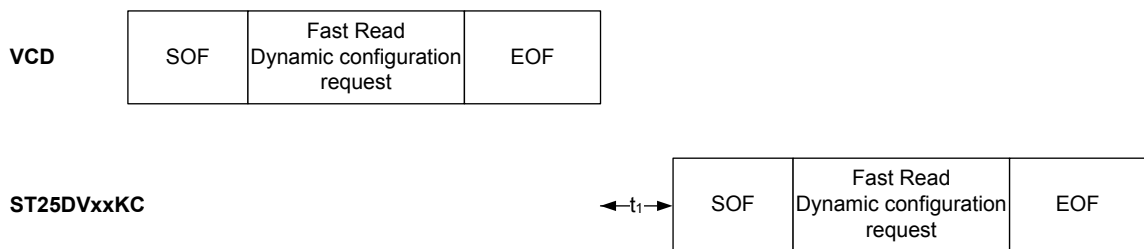
**Table 240. Fast Read Dynamic configuration response format when Error\_flag is set**

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 not supported
  - 0Fh: error with no information given
  - 10h: block not available

**Figure 78. Fast Read Dynamic configuration frame exchange between VCD and ST25DVxxKC**



#### 7.6.44 Fast Write Dynamic Configuration

On receiving the Fast Write Dynamic Configuration command, the ST25DVxxKC updates the Dynamic register addressed by the pointer.

The Option\_flag is not supported. The Inventory\_flag must be set to 0.

The data rate of the response is multiplied by 2 compared to Write Dynamic Configuration command.

**Table 241. Fast Write Dynamic Configuration request format**

Request SOF	Request_flags	Fast Write Dynamic Configuration	IC Mfg code	UID <sup>(1)</sup>	Pointer address	Register Value	CRC16	Request EOF
-	8 bits	CEh	02h	64 bits	8 bits	8 bits	16 bits	-

1. This field is optional.

Request parameters:

- Request flag
- UID (optional)
- Pointer address
- Register value

**Table 242. Fast Write Dynamic Configuration response format when Error\_flag is NOT set**

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

Response parameters:

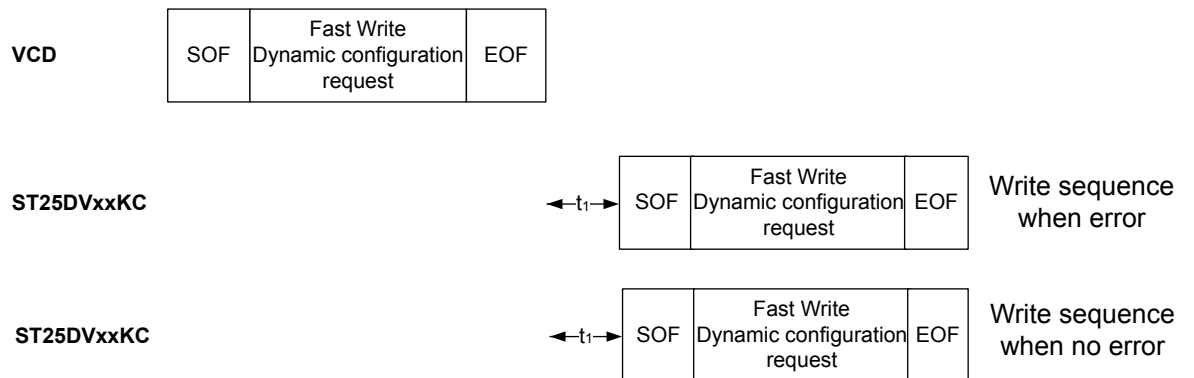
- No parameter. The response is sent back after  $t_1$ .

**Table 243. Fast Write Dynamic 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 not supported
  - 0Fh: error with no information given
  - 10h: block not available

**Figure 79. Fast Write Dynamic Configuration frame exchange between VCD and ST25DVxxKC**


## 8 Unique identifier (UID)

The ST25DVxxKC is uniquely identified by a 64-bit unique identifier (UID). This UID complies with ISO/IEC 15963 and ISO/IEC 7816-6. The UID is a read-only code and comprises:

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

**Table 244. UID format**

MSB				LSB			
63	56	55	48	47	40	39	0
0xE0		0x02		ST product code <sup>(1)</sup>		Unique serial number	

1. See [Table 86. UID for ST product code value definition.](#)

With the UID, each ST25DVxxKC can be addressed uniquely and individually during the anticollision loop and for one-to-one exchanges between a VCD and an ST25DVxxKC.

## 9 Device parameters

### 9.1 Maximum rating

Stressing the device above the rating listed in [Table 245](#) 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 245. Absolute maximum ratings**

Symbol	Parameter			Min.	Max.	Unit	
T <sub>A</sub>	Ambient operating temperature	Range 6	All packages	RF and I <sup>2</sup> C interfaces	-40	85	°C
		Range 8	UFDFPN8, UFDFPN12	RF and I <sup>2</sup> C interfaces	-40	105	°C
				RF interface	-40	105	°C
			SO8N, TSSOP	I <sup>2</sup> C interface	-40	125	°C
T <sub>STG</sub>	Storage temperature	UFDFPN8 (MLP8), SO8N, TSSOP8, UFDFPN12, WLCSP10		-65	150	°C	
T <sub>LEAD</sub>	Lead temperature during soldering			see note <sup>(1)</sup>		°C	
V <sub>IO</sub>	I <sup>2</sup> C input or output range			-0.50	6.5	V	
V <sub>CC</sub>	I <sup>2</sup> C supply voltage			-0.50	6.5	V	
I <sub>OL_MAX_SDA</sub>	DC output current on pin SDA (when equal to 0)			-	5	mA	
I <sub>OL_MAX_GPO</sub>	DC output current on pin GPO (when equal to 0)			-	1.5	mA	
V <sub>MAX_1</sub>	RF input voltage amplitude peak to peak between AC0 and AC1, V <sub>SS</sub> pin left floating <sup>(2)</sup>		V <sub>AC0</sub> - V <sub>AC1</sub>	-	11	V	
V <sub>MAX_2</sub>	AC voltage between AC0 and V <sub>SS</sub> , or AC1 and V <sub>SS</sub> <sup>(2)</sup>		V <sub>AC0</sub> - V <sub>SS</sub> , or V <sub>AC1</sub> - V <sub>SS</sub>	-0.50	5.5	V	
V <sub>ESD</sub>	Electrostatic discharge voltage (human body model) <sup>(3)</sup>		All pins	-	2000	V	

1. Compliant with JEDEC Std J-STD-020C (for small body, Sn-Pb or Pb assembly), the ST ECOPACK 7191395 specification, and the European directive on Restrictions on Hazardous Substances (RoHS) 2002/95/EU.

2. Evaluated By Characterization – Not tested in production.

3. AEC-Q100-002 (compliant with JEDEC Std JESD22-A114, C1 = 100 pF, R1 = 1500 Ω, R2 = 500 Ω)

## 9.2 I<sup>2</sup>C DC and AC parameters

This section summarizes the operating and measurement conditions, and the DC and AC characteristics of the device in I<sup>2</sup>C mode. The parameters in the DC and AC characteristic tables that follow are derived from tests performed under the measurement conditions summarized in the relevant tables. Designers should check that the operating conditions in their circuit match the measurement conditions when relying on the quoted parameters.

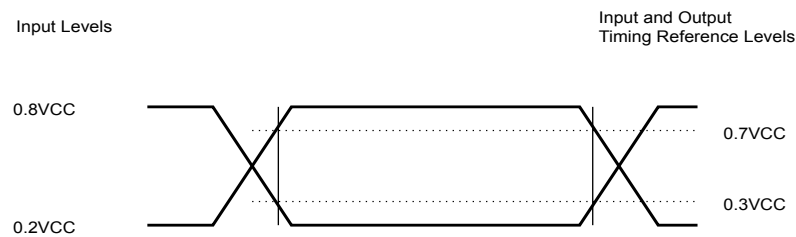
**Table 246. I<sup>2</sup>C operating conditions**

Symbol	Parameter		Min.	Max.	Unit		
V <sub>CC</sub>	Supply voltage		1.8	5.5	V		
T <sub>A</sub>	Ambient operating temperature	Range 6	All packages		-40	85	°C
		Range 8	UFD8FN8, UFD8FN12		-40	105	°C
			SO8N, TSSOP8		-40	125	°C

**Table 247. AC test measurement conditions**

Symbol	Parameter	Min.	Max.	Unit
C <sub>L</sub>	Load capacitance	100		pF
t <sub>r</sub> , t <sub>f</sub>	Input rise and fall times	-	50	ns
V <sub>hi-lo</sub>	Input levels	0.2V <sub>CC</sub> to 0.8V <sub>CC</sub>		V
V <sub>ref(t)</sub>	Input and output timing reference levels	0.3V <sub>CC</sub> to 0.7V <sub>CC</sub>		V

**Figure 80. AC test measurement I/O waveform**



**Table 248. Input parameters**

Symbol	Parameter	Min.	Max.	Unit
C <sub>IN</sub>	Input capacitance (SDA)	-	8	pF
C <sub>IN</sub>	Input capacitance (other pins)	-	6	pF
t <sub>NS</sub> <sup>(1)</sup>	Pulse width ignored (Input filter on SCL and SDA)	-	80	ns

1. Evaluated By Characterization – Not tested in production.

**Table 249. I<sup>2</sup>C DC characteristics up to 85 °C**

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
I <sub>LI</sub>	Input leakage current (SCL, SDA)	V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub> device in Standby mode	-	0.03	±0.1	μA
	Input leakage current (LPD)	V <sub>IN</sub> = V <sub>SS</sub> device in Standby mode	-	0.1	±0.5	μA
I <sub>LO</sub>	Output leakage current (SDA)	SDA in Hi-Z, external voltage applied on SDA: V <sub>SS</sub> or V <sub>CC</sub>	-	0.03	±0.1	μA
I <sub>CC_E<sup>2</sup></sub>	Operating Supply current (Device select E <sup>2</sup> Address) Read <sup>(1)</sup>	V <sub>CC</sub> = 1.8 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	116	160	μA
		V <sub>CC</sub> = 3.3 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	220	240	
		V <sub>CC</sub> = 5.5 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	510	550	
I <sub>CC_MB</sub>	Operating Supply current (Device select MB Address) Read <sup>(1)</sup>	V <sub>CC</sub> = 1.8 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	116	160	μA
		V <sub>CC</sub> = 3.3 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	220	240	
		V <sub>CC</sub> = 5.5 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	510	550	
I <sub>CC0</sub>	Operating Supply current (Device select E <sup>2</sup> Address) Write <sup>(1)</sup>	V <sub>CC</sub> = 1.8 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	110	210	μA
		V <sub>CC</sub> = 3.3 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	110	220	
		V <sub>CC</sub> = 5.5 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	130	250	
I <sub>CC0_MB</sub>	Operating Supply current (Device select MB Address) Write <sup>(1)</sup>	V <sub>CC</sub> = 1.8 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	170	200	μA
		V <sub>CC</sub> = 3.3 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	280	300	
		V <sub>CC</sub> = 5.5 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	520	600	
I <sub>CC1</sub> (LPD = 1)	Low power down supply current	V <sub>CC</sub> = 1.8 V	-	0.84	1.5	μA
		V <sub>CC</sub> = 3.3 V	-	1.3	2	
		V <sub>CC</sub> = 5.5 V	-	1.7	3	
I <sub>CC1_PON</sub> (LPD = 0)	Static Standby supply current after power ON or device select stop or time out	V <sub>CC</sub> = 1.8 V	-	72	100	μA
		V <sub>CC</sub> = 3.3 V	-	76	100	
		V <sub>CC</sub> = 5.5 V	-	87	120	
V <sub>IL</sub>	Input low voltage (SDA, SCL)	V <sub>CC</sub> = 1.8 V	-0.45	-	0.25 V <sub>CC</sub>	V
		V <sub>CC</sub> = 3.3 V	-0.45	-	0.3 V <sub>CC</sub>	
		V <sub>CC</sub> = 5.5 V	-0.45	-	0.3 V <sub>CC</sub>	
V <sub>IL_LPD</sub>	Input low voltage (LPD)	V <sub>CC</sub> = 3.3 V	-0.45	-	0.2 V <sub>CC</sub>	V

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V <sub>IH</sub>	Input high voltage (SDA, SCL)	V <sub>CC</sub> = 1.8 V	0.75 V <sub>CC</sub>	-	V <sub>CC</sub> + 1	V
		V <sub>CC</sub> = 3.3 V	0.75 V <sub>CC</sub>	-	V <sub>CC</sub> + 1	
		V <sub>CC</sub> = 5.5 V	0.75 V <sub>CC</sub>	-	V <sub>CC</sub> + 1	
V <sub>IH_LPD</sub>	Input high voltage (LPD)	V <sub>CC</sub> = 1.8 V	0.85 V <sub>CC</sub>	-	V <sub>CC</sub> + 1	V
		V <sub>CC</sub> = 3.3 V	0.85 V <sub>CC</sub>	-	V <sub>CC</sub> + 1	
		V <sub>CC</sub> = 5.5 V	0.85 V <sub>CC</sub>	-	V <sub>CC</sub> + 1	
V <sub>OL_SDA</sub>	Output low voltage SDA (1 MHz)	I <sub>OL</sub> = 1 mA, V <sub>CC</sub> = 1.8 V	-	0.05	0.4	V
		I <sub>OL</sub> = 2.1 mA, V <sub>CC</sub> = 3.3 V	-	0.075	0.4	
		I <sub>OL</sub> = 3 mA, V <sub>CC</sub> = 5.5 V	-	0.09	0.4	
V <sub>CC_Power_up</sub>	Device Select Acknowledge	f <sub>C</sub> = 100 KHz <sup>(2)</sup>	-	1.48	1.7	V

1. SCL, SDA connected to Ground or V<sub>CC</sub>. SDA connected to V<sub>CC</sub> through a pull-up resistor.
2. Evaluated by Characterization – Not tested in production.

**Table 250. I<sup>2</sup>C DC characteristics up to 125 °C**

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
I <sub>LI</sub>	Input leakage current (SCL, SDA)	V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub> device in Standby mode	-	0.03	±0.1	µA
	Input leakage current (LPD)	V <sub>IN</sub> = V <sub>SS</sub> device in Standby mode	-	0.1	±0.5	
I <sub>LO</sub>	Output leakage current (SDA)	SDA in Hi-Z, external voltage applied on SDA: V <sub>SS</sub> or V <sub>CC</sub>	-	0.03	±0.1	µA
I <sub>CC_E2</sub>	Operating Supply current (Device select E <sup>2</sup> Address) Read <sup>(1)</sup>	V <sub>CC</sub> = 1.8 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	126	180	µA
		V <sub>CC</sub> = 3.3 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	230	260	
		V <sub>CC</sub> = 5.5 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	510	550	
I <sub>CC_MB</sub>	Operating Supply current (Device select MB Address) Read <sup>(1)</sup>	V <sub>CC</sub> = 1.8 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	126	180	µA
		V <sub>CC</sub> = 3.3 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	230	260	
		V <sub>CC</sub> = 5.5 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	510	550	
I <sub>CC0</sub>	Operating Supply current (Device select E <sup>2</sup> Address) Write <sup>(1)</sup>	V <sub>CC</sub> = 1.8 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	120	220	µA
		V <sub>CC</sub> = 3.3 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	120	230	
		V <sub>CC</sub> = 5.5 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	140	260	
I <sub>CC0_MB</sub>	Operating Supply current (Device select MB Address) Write <sup>(1)</sup>	V <sub>CC</sub> = 1.8 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	180	220	µA



Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
I <sub>CC0_MB</sub>	Operating Supply current (Device select MB Address) Write <sup>(1)</sup>	V <sub>CC</sub> = 3.3 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	290	320	μA
		V <sub>CC</sub> = 5.5 V, f <sub>C</sub> = 1MHz (rise/fall time < 50 ns)	-	520	600	
I <sub>CC1</sub> (LPD = 1)	Low power down supply current	V <sub>CC</sub> = 1.8 V	-	2.5	5	μA
		V <sub>CC</sub> = 3.3 V	-	3	6	
		V <sub>CC</sub> = 5.5 V	-	4	7	
I <sub>CC1_PON</sub> (LPD = 0)	Static Standby supply current after power ON or device select stop or time out	V <sub>CC</sub> = 1.8 V	-	78	110	μA
		V <sub>CC</sub> = 3.3 V	-	82	110	
		V <sub>CC</sub> = 5.5 V	-	95	130	
V <sub>IL</sub>	Input low voltage (SDA, SCL)	V <sub>CC</sub> = 1.8 V	-0.45	-	0.25 V <sub>CC</sub>	V
		V <sub>CC</sub> = 3.3 V	-0.45	-	0.3 V <sub>CC</sub>	
		V <sub>CC</sub> = 5.5 V	-0.45	-	0.3 V <sub>CC</sub>	
V <sub>IL_LPD</sub>	Input low voltage (LPD)	V <sub>CC</sub> = 3.3 V	-0.45	-	0.2 V <sub>CC</sub>	V
V <sub>IH</sub>	Input high voltage (SDA, SCL)	V <sub>CC</sub> = 1.8 V	0.75 V <sub>CC</sub>	-	V <sub>CC</sub> +1	V
		V <sub>CC</sub> = 3.3 V	0.75 V <sub>CC</sub>	-	V <sub>CC</sub> +1	
		V <sub>CC</sub> = 5.5 V	0.75 V <sub>CC</sub>	-	V <sub>CC</sub> +1	
V <sub>IH_LPD</sub>	Input high voltage (LPD)	V <sub>CC</sub> = 1.8 V	0.85 V <sub>CC</sub> +1	-	V <sub>CC</sub> +1	V
		V <sub>CC</sub> = 3.3 V	0.85 V <sub>CC</sub> +1	-	V <sub>CC</sub> +1	
		V <sub>CC</sub> = 5.5 V	0.85 V <sub>CC</sub> +1	-	V <sub>CC</sub> +1	
V <sub>OL_SDA</sub>	Output low voltage SDA (1 MHz)	I <sub>OL</sub> = 1 mA, V <sub>CC</sub> = 1.8 V	-	0.05	0.4	V
		I <sub>OL</sub> = 2.1 mA, V <sub>CC</sub> = 3.3 V	-	0.08	0.4	
		I <sub>OL</sub> = 3 mA, V <sub>CC</sub> = 5.5 V	-	0.1	0.4	
V <sub>CC_Power_up</sub>	Device Select Acknowledge	f <sub>C</sub> = 100 KHz <sup>(2)</sup>	-	1.48	1.7	V

1. SCL, SDA connected to Ground or V<sub>CC</sub>. SDA connected to V<sub>CC</sub> through a pull-up resistor.

2. Evaluated by Characterization – Not tested in production.

**Table 251. I<sup>2</sup>C AC characteristics up to 85 °C**

Test conditions specified in Table 246. I <sup>2</sup> C operating conditions					
Symbol	Alt.	Parameter	Min.	Max.	Unit
$f_C$	$f_{SCL}$	Clock frequency	0.05	1000	kHz
$t_{CHCL}$	$t_{HIGH}$	Clock pulse width high <sup>(1)</sup>	0.26	25000 <sup>(2)</sup>	µs
$t_{CLCH}$	$t_{LOW}$	Clock pulse width low <sup>(1)</sup>	0.5	25000 <sup>(3)</sup>	µs
$t_{START\_OUT}$	-	I <sup>2</sup> C timeout on Start condition <sup>(1)</sup>	35	-	ms
$t_{XH1XH2}$	$t_R$	Input signal rise time <sup>(1)</sup>	-(4)	-(4)	ns
$t_{XL1XL2}$	$t_F$	Input signal fall time <sup>(1)</sup>	-(4)	-(4)	ns
$t_{DL1DL2}$	$t_F$	SDA (out) fall time <sup>(1)</sup>	20	120	ns
$t_{DXCX}$	$t_{SU:DAT}$	Data in set up time <sup>(1)</sup>	0	-	ns
$t_{CLDX}$	$t_{HD:DAT}$	Data in hold time	0	-	ns
$t_{CLQX}$	$t_{DH}$	Data out hold time <sup>(5)</sup>	100	-	ns
$t_{CLQV}$	$t_{AA}$	Clock low to next data valid (access time) <sup>(6)</sup>	-	450	ns
$t_{CHDX}$	$t_{SU:STA}$	Start condition set up time <sup>(7)</sup>	250	-	ns
$t_{DLCL}$	$t_{HD:STA}$	Start condition hold time	0.25	35000 <sup>(8)</sup>	µs
$t_{CHDH}$	$t_{SU:STO}$	Stop condition set up time	250	-	ns
$t_{DHDL}$	$t_{BUF}$	Time between Stop condition and next Start condition	1400	-	ns
$t_W$	-	I <sup>2</sup> C write time <sup>(9)</sup>	-	5	ms
$t_{bootDC}$	-	RF OFF and LPD = 0 <sup>(1)</sup>	-	0.6	ms
$t_{bootLPD}$	-	RF OFF <sup>(1)</sup>	-	0.6	ms

1. Evaluated by Characterization – Not tested in production.

2.  $t_{CHCL}$  timeout.

3.  $t_{CLCH}$  timeout.

4. There is no min. or max. values for the input signal rise and fall times. It is however recommended by the I<sup>2</sup>C specification that the input signal rise and fall times be less than 120 ns when  $f_C < 1$  MHz.

5. To avoid spurious Start and Stop conditions, a minimum delay is placed between SCL=1 and the falling or rising edge of SDA.

6.  $t_{CLQV}$  is the time (from the falling edge of SCL) required by the SDA bus line to reach 0.8VCC in a compatible way with the I<sup>2</sup>C specification (which specifies  $t_{SU:DAT}$  (min) = 100 ns), assuming that the  $R_{bus} \times C_{bus}$  time constant is less than 150 ns (as specified in the Figure 82. I<sup>2</sup>C Fast mode ( $f_C = 1$  MHz): maximum  $R_{bus}$  value versus bus parasitic capacitance ( $C_{bus}$ )).

7. For a reStart condition, or following a write cycle.

8.  $t_{DLCL}$  timeout

9. I<sup>2</sup>C write time for 1 Byte, up to 16 Bytes in EEPROM (user memory) provided they are all located in the same memory row, that is the most significant memory address bits (b16-b4) are the same.

**Table 252. I<sup>2</sup>C AC characteristics up to 125 °C**

Test conditions specified in Table 246. I <sup>2</sup> C operating conditions					
Symbol	Alt.	Parameter	Min.	Max.	Unit
$f_C$	$f_{SCL}$	Clock frequency	0.05	1000	kHz
$t_{CHCL}$	$t_{HIGH}$	Clock pulse width high	0.26	25000 <sup>(1)</sup>	µs
$t_{CLCH}$	$t_{LOW}$	Clock pulse width low	0.5	25000 <sup>(2)</sup>	µs
$t_{START\_OUT}$	-	I <sup>2</sup> C timeout on Start condition <sup>(3)</sup>	35	-	ms
$t_{XH1XH2}$	$t_R$	Input signal rise time <sup>(3)</sup>	-( <sup>4</sup> )	-( <sup>4</sup> )	ns
$t_{XL1XL2}$	$t_F$	Input signal fall time <sup>(3)</sup>	-( <sup>4</sup> )	-( <sup>4</sup> )	ns
$t_{DL1DL2}$	$t_F$	SDA (out) fall time <sup>(3)</sup>	20	120	ns
$t_{DXCX}$	$t_{SU:DAT}$	Data in set up time <sup>(3)</sup>	0	-	ns
$t_{CLDX}$	$t_{HD:DAT}$	Data in hold time	0	-	ns
$t_{CLQX}$	$t_{DH}$	Data out hold time <sup>(5)</sup>	100	-	ns
$t_{CLQV}$	$t_{AA}$	Clock low to next data valid (access time) <sup>(6)</sup>	-	450	ns
$t_{CHDX}$	$t_{SU:STA}$	Start condition set up time <sup>(7)</sup>	250	-	ns
$t_{DLCL}$	$t_{HD:STA}$	Start condition hold time	0.25	35000 <sup>(8)</sup>	µs
$t_{CHDH}$	$t_{SU:STO}$	Stop condition set up time	250	-	ns
$t_{DHDL}$	$t_{BUF}$	Time between Stop condition and next Start condition	1400	-	ns
$t_W$	-	I <sup>2</sup> C write time <sup>(9)</sup>	-	5.5	ms
$t_{bootDC}$	-	RF OFF and LPD = 0 <sup>(3)</sup>	-	-	ms
$t_{boot\_LPD}$	-	RF OFF <sup>(3)</sup>	-	0.6	ms

- $t_{CHCL}$  timeout.
- $t_{CLCH}$  timeout.
- Evaluated by Characterization – Not tested in production.
- There is no min. or max. values for the input signal rise and fall times. It is however recommended by the I<sup>2</sup>C specification that the input signal rise and fall times be less than 120 ns when  $f_C < 1$  MHz.
- To avoid spurious Start and Stop conditions, a minimum delay is placed between SCL=1 and the falling or rising edge of SDA.
- $t_{CLQV}$  is the time (from the falling edge of SCL) required by the SDA bus line to reach 0.8V<sub>CC</sub> in a compatible way with the I<sup>2</sup>C specification (which specifies  $t_{SU:DAT}$  (min) = 100 ns), assuming that the  $R_{bus} \times C_{bus}$  time constant is less than 150 ns (as specified in the Figure 82. I<sup>2</sup>C Fast mode ( $f_C = 1$  MHz): maximum  $R_{bus}$  value versus bus parasitic capacitance ( $C_{bus}$ )).
- For a restart condition, or following a write cycle.
- $t_{DLCL}$  timeout.
- I<sup>2</sup> write time for 1 Byte, up to 16 Bytes in EEPROM (user memory) provided they are all located in the same memory row, that is the most significant memory address bits (b16-b4) are the same.

Figure 81. I<sup>2</sup>C AC waveforms

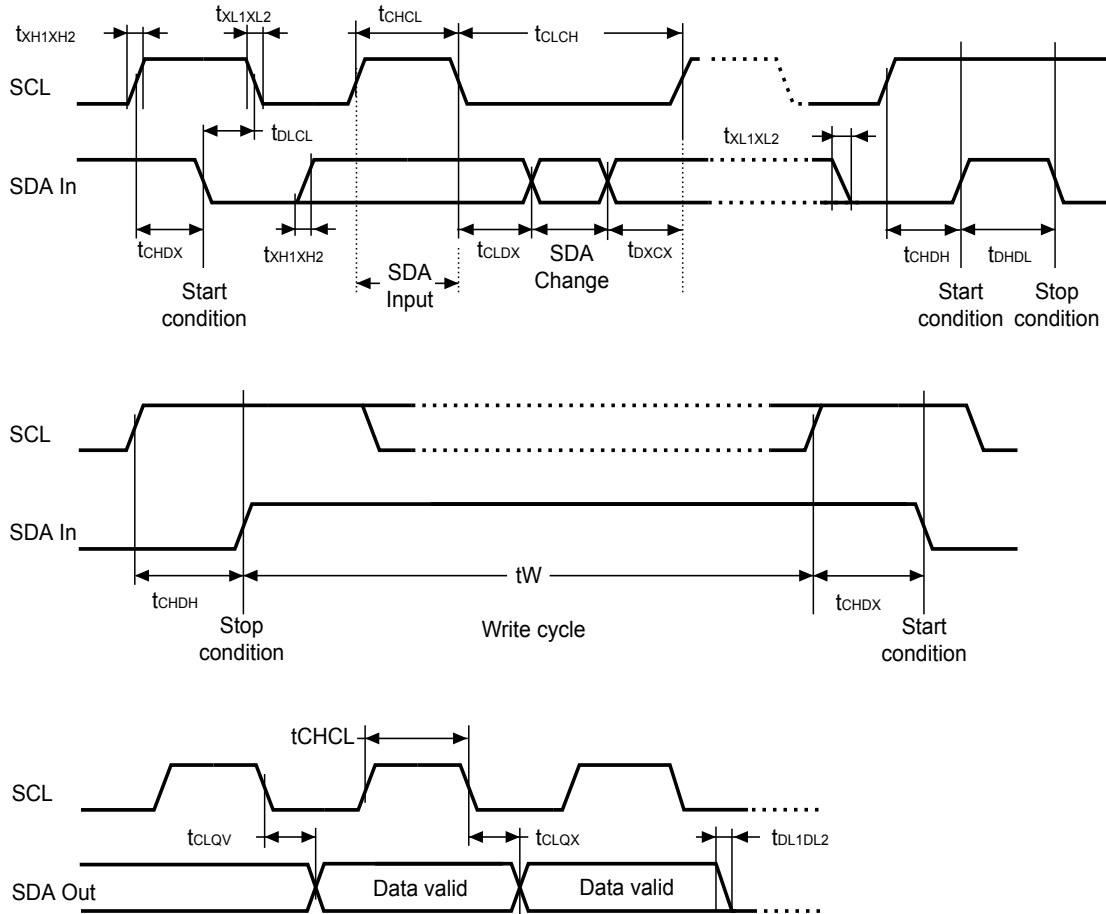
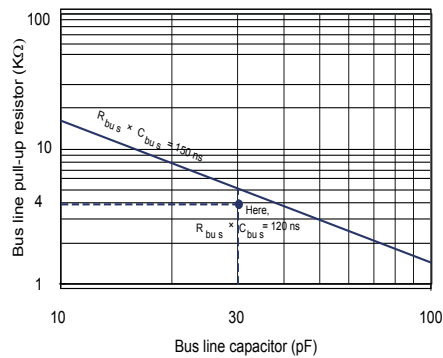
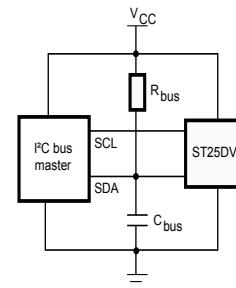


Figure 82 indicates how the value of the pull-up resistor can be calculated. In most applications, though, this method of synchronization is not employed, and so the pull-up resistor is not necessary, provided that the bus master has a push-pull (rather than open drain) output.

Figure 82. I<sup>2</sup>C Fast mode ( $f_C = 1$  MHz): maximum  $R_{bus}$  value versus bus parasitic capacitance ( $C_{bus}$ )



The  $R_{bus} \times C_{bus}$  time constant must be below 150 ns. The time constant line is represented on the left.



### 9.3 GPO characteristics

This section summarizes the operating and measurement conditions of the GPO feature. The parameters in the DC and AC characteristic tables that follow are derived from tests performed under the measurement conditions summarized in the relevant tables.

**Table 253. GPO DC characteristics up to 85 °C**

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V <sub>OL_GPO_CMOS</sub>	Output low voltage (GPO CMOS)	V <sub>DCG</sub> = 1.8 V, I <sub>OL</sub> = 0.5 mA	-	-	0.4	V
		V <sub>DCG</sub> = 3.3 V, I <sub>OL</sub> = 0.5 mA	-	-	0.4	V
		V <sub>DCG</sub> = 5.5 V, I <sub>OL</sub> = 0.5 mA	-	-	0.4	V
V <sub>OH_GPO_CMOS</sub>	Output high voltage (GPO CMOS)	V <sub>DCG</sub> = 1.8 V, I <sub>OL</sub> = 0.5 mA	V <sub>DCG</sub> -0.4	-	-	V
		V <sub>DCG</sub> = 3.3 V, I <sub>OL</sub> = 0.5 mA	V <sub>DCG</sub> -0.4	-	-	V
		V <sub>DCG</sub> = 5.5 V, I <sub>OL</sub> = 0.5 mA	V <sub>DCG</sub> -0.4	-	-	V
V <sub>OL_GPO_OD</sub>	Output low voltage (GPO open drain)	I <sub>OL</sub> = 1 mA, V <sub>CC</sub> = 1.8 V	-	0.28	0.4	V
		I <sub>OL</sub> = 1 mA, V <sub>CC</sub> = 3.3 V	-	0.2	0.4	
		I <sub>OL</sub> = 1 mA, V <sub>CC</sub> = 5.5 V	-	0.2	0.4	
I <sub>L_GPO_OD</sub>	Output leakage current (GPO open drain)	GPO in Hi-Z, external voltage applied on: GPO, V <sub>SS</sub> or V <sub>CC</sub>	-0.15	0.06	0.15	μA
I <sub>LI_VDCG</sub>	Input leakage (V <sub>DCG</sub> )	V <sub>DCG</sub> = 5.5 V	-	-	0.1	μA

**Table 254. GPO DC characteristics up to 125 °C**

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V <sub>OL_GPO_CMOS</sub>	Output low voltage (GPO CMOS)	V <sub>DCG</sub> = 1.8 V, I <sub>OL</sub> = 0.5 mA	-	-	0.4	V
		V <sub>DCG</sub> = 3.3 V, I <sub>OL</sub> = 0.5 mA	-	-	0.4	V
		V <sub>DCG</sub> = 5.5 V, I <sub>OL</sub> = 0.5 mA	-	-	0.4	V
V <sub>OH_GPO_CMOS</sub>	Output high voltage (GPO CMOS)	V <sub>DCG</sub> = 1.8 V, I <sub>OL</sub> = 0.5 mA	V <sub>DCG</sub> -0.4	-	-	V
		V <sub>DCG</sub> = 3.3 V, I <sub>OL</sub> = 0.5 mA	V <sub>DCG</sub> -0.4	-	-	V
		V <sub>DCG</sub> = 5.5 V, I <sub>OL</sub> = 0.5 mA	V <sub>DCG</sub> -0.4	-	-	V
V <sub>OL_GPO_OD</sub>	Output low voltage (GPO open drain)	I <sub>OL</sub> = 1 mA, V <sub>CC</sub> = 1.8 V	-	0.28	0.4	V
		I <sub>OL</sub> = 1 mA, V <sub>CC</sub> = 3.3 V	-	0.22	0.4	
		I <sub>OL</sub> = 1 mA, V <sub>CC</sub> = 5.5 V	-	0.21	0.4	
I <sub>L_GPO_OD</sub>	Output leakage current (GPO open drain)	GPO in Hi-Z, external voltage applied on: GPO, V <sub>SS</sub> or V <sub>CC</sub>	-0.15	0.06	0.15	μA
I <sub>LI_VDCG</sub>	Input leakage (V <sub>DCG</sub> )	V <sub>DCG</sub> = 5.5 V	-	-	0.1	μA

**Table 255. GPO AC characteristics**

Symbol	Parameter	Test condition	Min.	Max	Unit
t <sub>r_GPO_CMOS</sub>	Output rise time <sup>(1)</sup>	C <sub>L</sub> = 30 pF, V <sub>DCG</sub> = 1.8 V to 5.5 V	-	50	ns
t <sub>f_GPO_CMOS</sub>	Output fall time <sup>(1)</sup>	C <sub>L</sub> = 30 pF, V <sub>DCG</sub> = 1.8 V to 5.5 V	-	50	ns

1. Evaluated by Characterization – Not tested in production.

## 9.4 RF electrical parameters

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

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

**Table 256. RF characteristics**

Symbol	Parameter	Condition	Min	Typ	Max	Unit
f <sub>CC</sub>	External RF signal frequency	-	13.553	13.56	13.567	MHz
H <sub>ISO</sub>	Operating field according to ISO <sup>(1)</sup>	Range 6 T <sub>A</sub> = -40 °C to 85 °C	150	-	5000	mA/m
		Range 8 T <sub>A</sub> = -40 °C to 105 °C				
MI <sub>CARRIER</sub>	10% carrier modulation index MI=(A-B)/(A+B)	150 mA/m > H <sub>ISO</sub> > 1000 mA/m	10	-	30	%
	100% carrier modulation index	MI=(A-B)/(A+B) <sup>(2)</sup>	95	-	100	
t <sub>MIN CD</sub>	Minimum time from carrier generation to first data <sup>(1)</sup>	From H-field min	-	-	1	ms
f <sub>SH</sub>	Subcarrier frequency high <sup>(1)</sup>	F <sub>CC</sub> /32	-	423.75	-	kHz
f <sub>SL</sub>	Subcarrier frequency low <sup>(1)</sup>	F <sub>CC</sub> /28	-	484.28	-	kHz
t <sub>1</sub>	Time for ST25DVxxKC response <sup>(1)</sup>	4352/F <sub>C</sub>	318.6	320.9	323.3	µs
t <sub>2</sub>	Time between commands <sup>(1)</sup>	4192/F <sub>C</sub>	309	311.5	314	µs
t <sub>3</sub>	Time between commands <sup>(1)</sup>	4384/F <sub>C</sub>	323.3	-	-	µs
W <sub>t_Block</sub>	RF User memory write time (including internal Verify) <sup>(1)(3)</sup>	1 Block	-	5.2	-	ms
		4 Blocks	-	19.7	-	ms
W <sub>t_Byte</sub>	RF system memory write time including internal Verify <sup>(1)(3)</sup>	1 Byte	-	4.9	-	ms
W <sub>t_MB</sub>	RF Mailbox write time (from VCD request SOF to ST25DVxxKC response EOF) <sup>(1)(3)</sup>	256 Byte	-	80.7	-	ms
Read_MB	RF Mailbox read time (from VCD request SOF to ST25DVxxKC response EOF) <sup>(1)(3)</sup>	256 Byte	-	81	-	ms
C <sub>TUN</sub>	Internal tuning capacitor <sup>(2)</sup>	f = 13.56 MHz	-	28.5	-	pF
V <sub>BACK</sub>	Backscattered level as defined by ISO test	-	10	-	-	mV
V <sub>MIN_1</sub>	RF input voltage amplitude between AC0 and AC1, V <sub>SS</sub> pin left floating, VAC0-VAC1 peak to peak <sup>(1)</sup>	Inventory and Read operations	-	4.8	-	V
		Write operations	-	5.25	-	V
V <sub>MIN_2</sub>	AC voltage between AC0 and V <sub>SS</sub> or between AC1 and V <sub>SS</sub> <sup>(1)</sup>	Inventory and Read operations	-	2.25	-	V
		Write operations	-	2.7	-	V
t <sub>BootRF</sub>	Without DC supply (No V <sub>CC</sub> ) <sup>(1)</sup>	Set up time	-	0.6	-	ms
t <sub>RF_OFF</sub>	RF OFF time <sup>(1)</sup>	Chip reset	2	-	-	ms

1. Evaluated by Characterization – Not tested in production.
2. Evaluated by Characterization – Tested in production by correlating industrial tester measure with characterization results.
3. For VCD request coded in 1 out of 4 and ST25DVxxKC response in high data rate, single sub carrier.

Note: All timing characterization where performed on a reference antenna with the following characteristics:

- ISO antenna class 1
- Tuning frequency = 13.7 MHz

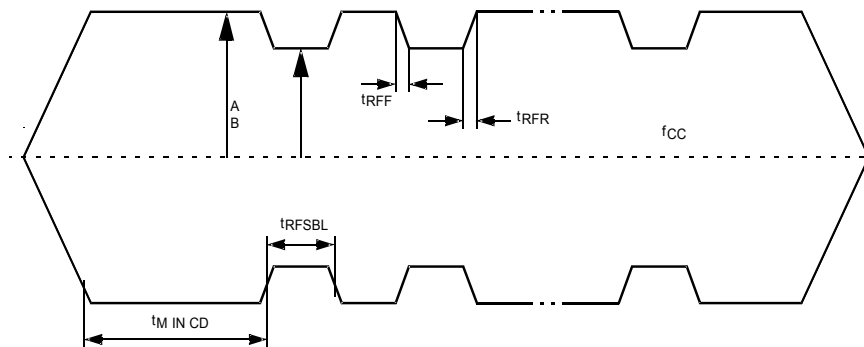
**Table 257. Operating conditions**

Symbol	Parameter	Min.	Max.	Unit	
$T_A$	Ambient operating temperature	Range 6	-40	85	°C
		Range 8	-40	105	

Figure 83. ASK modulated signal shows an ASK modulated signal from the VCD to the ST25DVxxKC. The test conditions for the AC/DC parameters are:

- Close coupling condition with tester antenna (1 mm)
- ST25DVxxKC performance measured at the tag antenna
- ST25DVxxKC synchronous timing, transmit and receive

**Figure 83. ASK modulated signal**



## 9.5 Thermal characteristics

**Table 258. Thermal characteristics**

Symbol	Parameter	Value	Unit
$\Theta_{JA}$	Thermal resistance junction-ambient SO8N 4.9 x 6 mm, 1.27 mm pitch package <sup>(1)</sup>	219	°C/W
	Thermal resistance junction-ambient TSSOP8 3 x 6.4 mm, 0.65 mm pitch package <sup>(1)</sup>	255	
	Thermal resistance junction-ambient UFDN8 2 x 3 mm, 0.5 mm pitch package <sup>(1)(2)</sup>	67	

1. Jedec JESD51-7 2s2p board
2. Exposed pad soldered to board

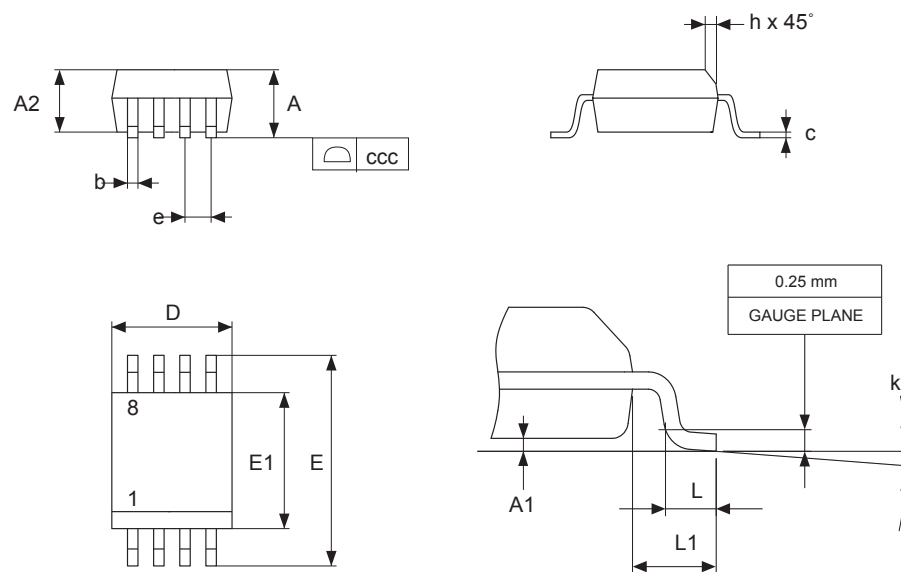
## 10 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

### 10.1 SO8N package information

This SO8N is an 8-lead, 4.9 x 6 mm, plastic small outline, 150 mils body width, package.

Figure 84. SO8N – Outline



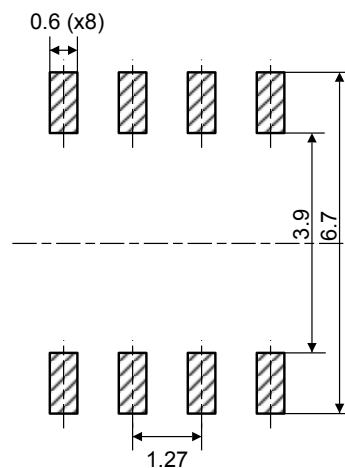
1. Drawing is not to scale.



**Table 259. SO8N – Mechanical data**

Symbol	millimeters			inches <sup>(1)</sup>		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	-	-	1.750	-	-	0.0689
A1	0.100	-	0.250	0.0039	-	0.0098
A2	1.250	-	-	0.0492	-	-
b	0.280	-	0.480	0.0110	-	0.0189
c	0.170	-	0.230	0.0067	-	0.0091
D	4.800	4.900	5.000	0.1890	0.1929	0.1969
E	5.800	6.000	6.200	0.2283	0.2362	0.2441
E1	3.800	3.900	4.000	0.1496	0.1535	0.1575
e	-	1.270	-	-	0.0500	-
h	0.250	-	0.500	0.0098	-	0.0197
k	0°	-	8°	0°	-	8°
L	0.400	-	1.270	0.0157	-	0.0500
L1	-	1.040	-	-	0.0409	-
ccc	-	-	0.100	-	-	0.0039

1. Values in inches are converted from mm and rounded to four decimal digits.

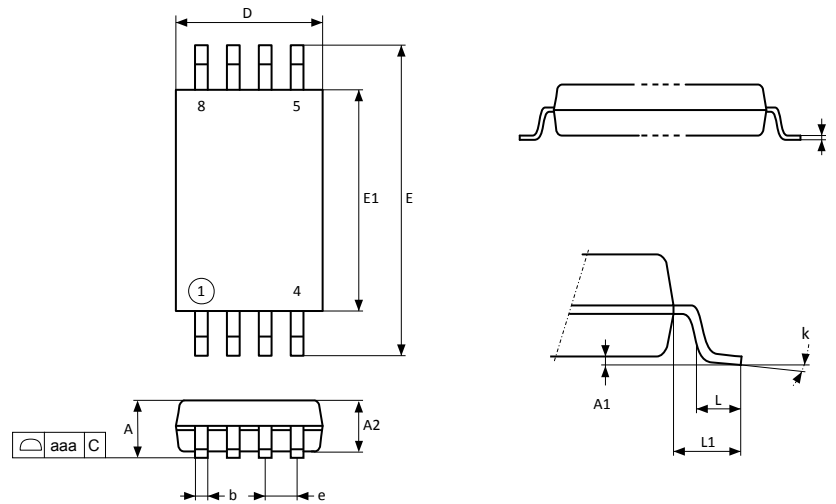
**Figure 85. SO8N - Recommended footprint**


1. Dimensions are expressed in millimeters.

## 10.2 TSSOP8 package information

TSSOP8 is an 8-lead thin shrink small outline, 3 x 6.4 mm, 0.65 mm pitch, package.

**Figure 86. TSSOP8 – Outline**



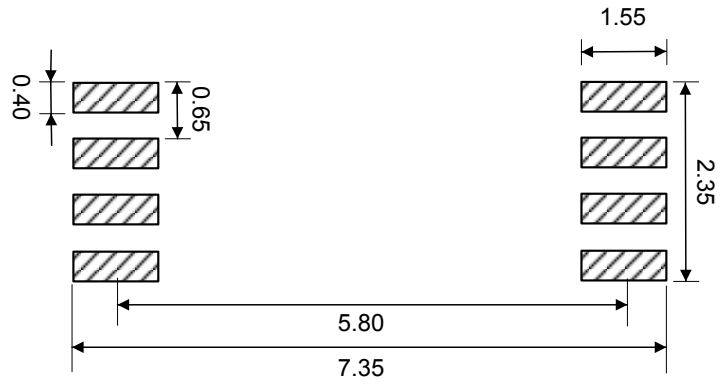
1. Drawing is not to scale.

**Table 260. TSSOP8 – Mechanical data**

Symbol	millimeters			inches <sup>(1)</sup>		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	-	-	1.200	-	-	0.0472
A1	0.050	-	0.150	0.0020	-	0.0059
A2	0.800	1.000	1.050	0.0315	0.0394	0.0413
b	0.190	-	0.300	0.0075	-	0.0118
c	0.090	-	0.200	0.0035	-	0.0079
CP	-	-	0.100	-	-	0.0039
D	2.900	3.000	3.100	0.1142	0.1181	0.1220
e	-	0.650	-	-	0.0256	-
E	6.200	6.400	6.600	0.2441	0.2520	0.2598
E1	4.300	4.400	4.500	0.1693	0.1732	0.1772
L	0.450	0.600	0.750	0.0177	0.0236	0.0295
L1	-	1.000	-	-	0.0394	-
k	0°	-	8°	0°	-	8°
aaa	-	-	0.100	-	-	0.0039

1. Values in inches are converted from mm and rounded to four decimal digits.

Figure 87. TSSOP8 – Recommended footprint

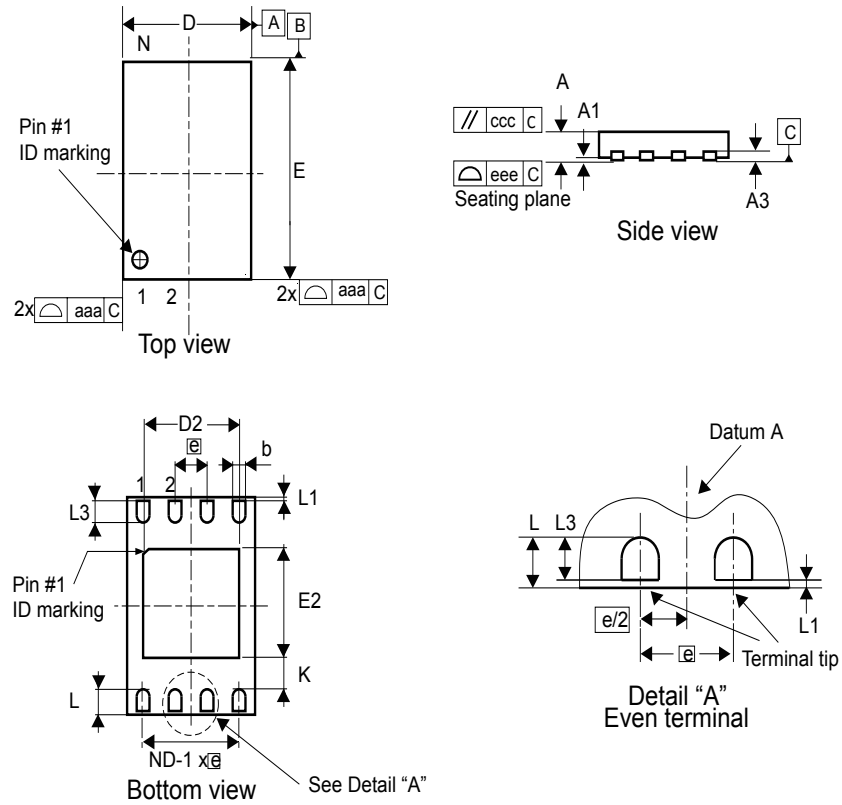


1. Dimensions are expressed in millimeters.

### 10.3 UFDNF8 package information

UFDNF8 is an 8-lead, 2 × 3 mm, 0.5 mm pitch ultra thin profile fine pitch dual flat package.

Figure 88. UFDNF8 - Outline



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

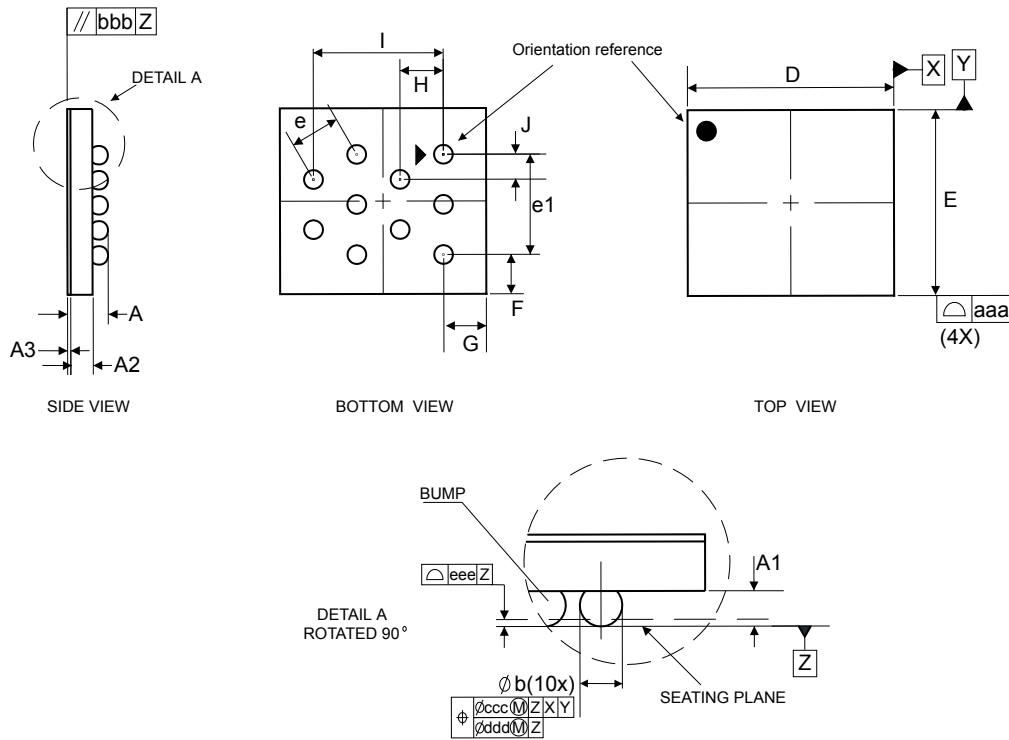
**Table 261. UDFN8 - Mechanical data**

Symbol	millimeters			inches <sup>(1)</sup>		
	Min	Typ	Max	Min	Typ	Max
A	0.450	0.550	0.600	0.0177	0.0217	0.0236
A1	0.000	0.020	0.050	0.0000	0.0008	0.0020
b <sup>(2)</sup>	0.200	0.250	0.300	0.0079	0.0098	0.0118
D	1.900	2.000	2.100	0.0748	0.0787	0.0827
D2	1.200	-	1.600	0.0472	-	0.0630
E	2.900	3.000	3.100	0.1142	0.1181	0.1220
E2	1.200	-	1.600	0.0472	-	0.0630
e	-	0.500	-	0.0197		
K	0.300	-	-	0.0118	-	-
L	0.300	-	0.500	0.0118	-	0.0197
L1	-	-	0.150	-	-	0.0059
L3	0.300	-	-	0.0118	-	-
aaa	-	-	0.150	-	-	0.0059
bbb	-	-	0.100	-	-	0.0039
ccc	-	-	0.100	-	-	0.0039
ddd	-	-	0.050	-	-	0.0020
eee <sup>(3)</sup>	-	-	0.080	-	-	0.0031

1. Values in inches are converted from mm and rounded to 4 decimal digits.
2. Dimension b applies to plated terminal and is measured between 0.15 and 0.30 mm from the terminal tip.
3. Applied for exposed die paddle and terminals. Exclude embedding part of exposed die paddle from measuring.

## 10.4 WLCSP10 package information

**Figure 89. WLCSP - 10 balls, 1.649x1.483 mm, 0.4 mm pitch, wafer level chip scale package outline**



1. Drawing is not to scale.
2. Dimension is measured at the maximum bump diameter parallel to primary datum Z.
3. Primary datum Z and seating plane are defined by the spherical crowns of the bump.
4. Bump position designation per JESD 95-1, SPP-010.

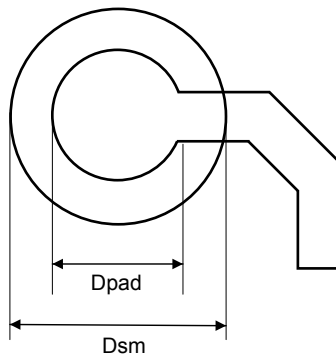
**Table 262. WLCSP - 10 balls, 1.649x1.483 mm, 0.4 mm pitch, wafer level chip scale mechanical data**

Symbol	millimeters			inches <sup>(1)</sup>		
	Min	Typ	Max	Min	Typ	Max
A	0.265	0.295	0.325	0.0104	0.0116	0.0128
A1	-	0.095	-	-	0.0037	-
A2	-	0.175	-	-	0.0069	-
A3	-	0.025	-	-	0.0010	-
b	-	0.185	-	-	0.0073	-
D	-	1.649	1.669	-	0.0649	0.0657
E	-	1.483	1.503	-	0.0584	0.0592
e	-	0.400	-	-	0.0157	-
e1	-	0.800	-	-	0.0315	-
H	-	0.346	-	-	0.0136	-
I	-	1.039	-	-	0.0409	-

Symbol	millimeters			inches <sup>(1)</sup>		
	Min	Typ	Max	Min	Typ	Max
J	-	0.200	-	-	0.0079	-
F	-	0.314	-	-	0.0124	-
G	-	0.342	-	-	0.0135	-
aaa	-	0.110	-	-	0.0043	-
bbb	-	0.110	-	-	0.0043	-
ccc	-	0.110	-	-	0.0043	-
ddd	-	0.060	-	-	0.0024	-
eee	-	0.060	-	-	0.0024	-

1. Values in inches are converted from mm and rounded to 4 decimal digits.

**Figure 90. WLCSP - 10 balls, 1.649x1.483 mm, 0.4 mm pitch, wafer level chip scale recommended footprint**



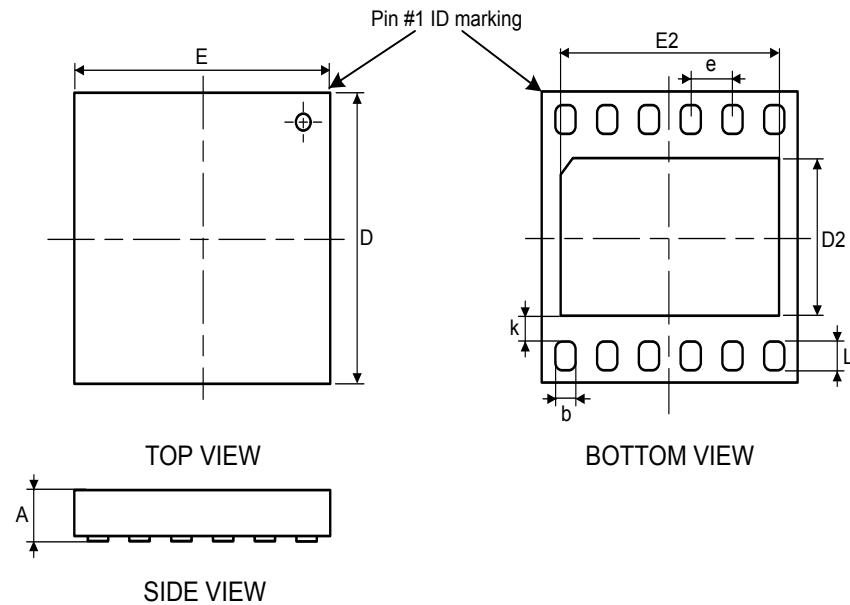
**Table 263. WLCSP10 recommended PCB design rules**

Dimension	Recommended values
Pitch	0.4 mm
Dpad	0,225 mm
Dsm	0.290 mm typ. (depends on soldermask registration tolerance)
Stencil opening	0.250 mm
Stencil thickness	0.100 mm

## 10.5 UFDFPN12 package information

UFDFPN12 is an 12-lead, 3 x 3 mm, 0.5 mm pitch ultra thin profile fine pitch dual flat package.

Figure 91. UFDFPN12 - Outline



1. Drawing is not to scale.

Table 264. UFDFPN12 - Mechanical data

Symbol	millimeters			inches <sup>(1)</sup>		
	Min	Typ	Max	Min	Typ	Max
A <sup>(2)</sup>	0.45	0.55	0.60	0.0177	0.0217	0.0236
b	0.20	0.25	0.30	0.0079	0.0098	0.0118
D	2.95	3.00	3.10	0.1161	0.1181	0.1220
D2	1.35	1.40	1.45	0.0531	0.0551	0.0571
e	0.50			0.0197		
E	2.95	3.00	3.10	0.1161	0.1181	0.1220
E2	2.50	2.55	2.60	0.0984	0.1004	0.1024
L	0.25	0.30	0.35	0.0098	0.0118	0.0138
k	0.40			0.0157		

1. Values in inches are converted from mm and rounded to 4 decimal digits.

2. Package total thickness.



## 11 Ordering information

**Table 265. Ordering information scheme**

Example:	ST25DV	64K	C	- IE	6	D	3
<b>Device type</b>							
<b>ST25DV = Dynamic NFC/RFID tag based on ISO 15693 and NFC T5T</b>							
<b>Memory size</b>							
04K = 4 Kbits							
16K = 16 Kbits							
64K = 64 Kbits							
<b>Version</b>							
C							
<b>Device Features</b>							
IE = I2C and GPO open drain, fast transfer mode and energy harvesting							
JF = I2C and GPO CMOS, fast transfer mode, energy harvesting and low power mode							
<b>Device grade</b>							
6 = industrial: device tested with standard test flow over - 40 to 85 °C							
8 = industrial device tested with standard test flow over -40 to 105 °C (UFDFPN8 and UFDFPN12 only) or over -40 to 125 °C (SO8N and TSSOP8 only, 105 °C only for RF interface)							
<b>Package</b>							
S = SO8N							
T = TSSOP8							
D = UFDFPN12							
C = UFDFPN8 (Only for 04K version)							
L = WLCSP (thin 10 balls) (Only for 04K version)							
<b>Capacitance</b>							
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

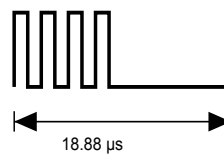
Data bits are encoded using Manchester coding, according to the following schemes. For the low data rate, same subcarrier frequency or frequencies is/are used. In this case, the number of pulses is multiplied by 4 and all times increase by this factor. For the Fast commands using one subcarrier, all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

### A.1 Bit coding using one subcarrier

#### A.1.1 High data rate

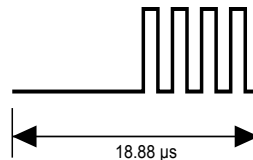
For the fast commands, a logic 0 starts with four pulses at 423.75 kHz ( $f_C/32$ ) followed by an unmodulated time of 9.44  $\mu\text{s}$ , as shown in Figure 92.

**Figure 92. Logic 0, high data rate, fast commands**



For the Fast commands, a logic 1 starts with an unmodulated time of 9.44  $\mu\text{s}$  followed by four pulses of 423.75 kHz ( $f_C/32$ ), as shown in Figure 93.

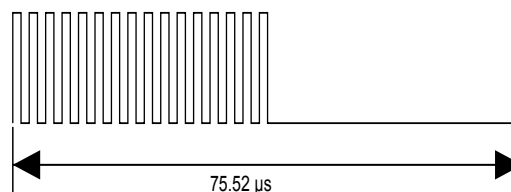
**Figure 93. Logic 1, high data rate, fast commands**



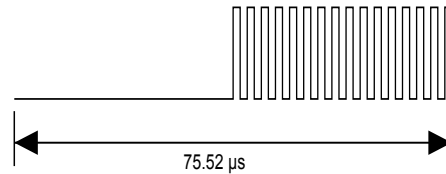
#### A.1.2 Low data rate

For the Fast commands, a logic 0 starts with 16 pulses at 423.75 kHz ( $f_C/32$ ) followed by an unmodulated time of 37.76  $\mu\text{s}$ , as shown in Figure 94.

**Figure 94. Logic 0, low data rate, fast commands**



For the Fast commands, a logic 1 starts with an unmodulated time of 37.76  $\mu\text{s}$  followed by 16 pulses at 423.75 kHz ( $f_C/32$ ), as shown in Figure 95.

**Figure 95. Logic 1, low data rate, fast commands**


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

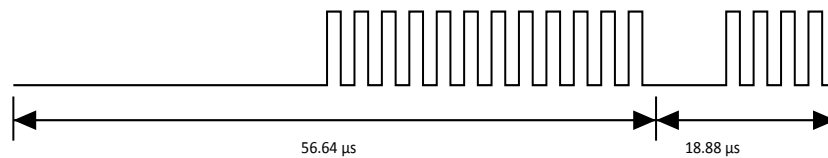
## A.2 ST25DVxxKC to VCD frames

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

## A.3 SOF when using one subcarrier

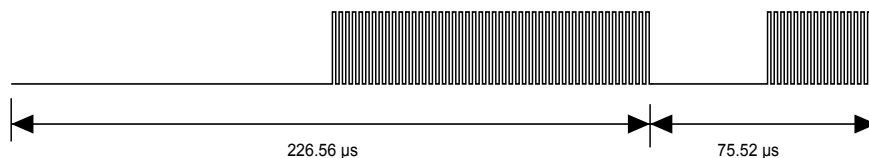
### A.3.1 High data rate

For the Fast commands, the SOF comprises an unmodulated time of 28.32  $\mu\text{s}$ , followed by 12 pulses at 423.75 kHz ( $f_C/32$ ), and a logic 1 that consists of an unmodulated time of 9.44  $\mu\text{s}$  followed by four pulses at 423.75 kHz, as shown in Figure 96.

**Figure 96. Start of frame, high data rate, one subcarrier, fast commands**


### A.3.2 Low data rate

For the Fast commands, the SOF comprises an unmodulated time of 113.28  $\mu\text{s}$ , followed by 48 pulses at 423.75 kHz ( $f_C/32$ ), and a logic 1 that includes an unmodulated time of 37.76  $\mu\text{s}$  followed by 16 pulses at 423.75 kHz, as shown in Figure 97.

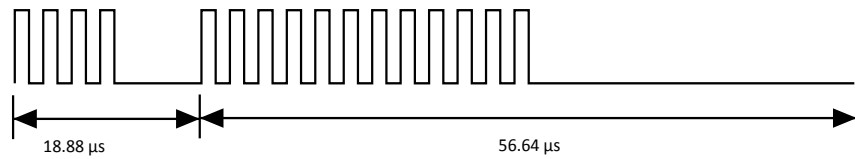
**Figure 97. Start of frame, low data rate, one subcarrier, fast commands**


## 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  $\mu\text{s}$ , followed by 12 pulses at 423.75 kHz ( $f_C/32$ ) and an unmodulated time of 37.76  $\mu\text{s}$ , as shown in Figure 98.

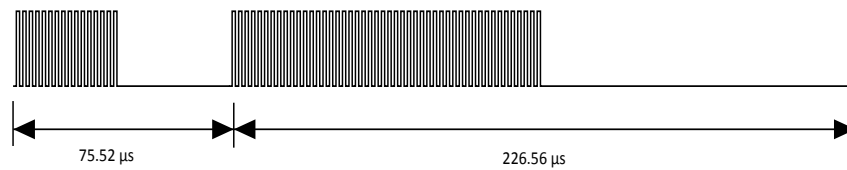
Figure 98. End of frame, high data rate, one subcarrier, fast commands



### 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  $\mu\text{s}$ , followed by 48 pulses at 423.75 kHz ( $f_C/32$ ) and an unmodulated time of 113.28  $\mu\text{s}$ , as shown in Figure 99.

Figure 99. End of frame, low data rate, one subcarrier, fast commands



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

## Appendix B I<sup>2</sup>C sequences

### B.1 Device select codes

Following table assumes default values for I2C\_DEVICE\_CODE[3:0] (1010b) and E0 (1b) bits. Device select value should be adapted to I2C\_DEVICE\_CODE[3:0] and E0 values programmed into the I2C\_CFG static register if different from default factory values.

**Table 266. Device select usage**

Device select value		Comment
Hexadecimal	Binary	
-	1010 E211 R/W	Device select generic E2 = 0b User memory, Dynamic registers, FTM mailbox E2 = 1b System memory
A6h	1010 0110b	User memory, Dynamic registers, FTM mailbox writing
A7h	1010 0111b	User memory, Dynamic registers, FTM mailbox reading
A Eh	1010 1110b	System memory writing
A Fh	1010 1111b	System memory reading

### B.2 I<sup>2</sup>C Byte writing and polling

#### B.2.1 I<sup>2</sup>C byte write in user memory

**Table 267. Byte Write in user memory when write operation allowed**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
DATA	-	Send Data (1 Byte)
-	ACK	9th bit
Stop	-	Start of Programming

**Table 268. Polling during programming after byte writing in user memory**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
<b>Start</b> A6h	-	Device select for writing
-	NoACK	9th bit Device Busy
<b>Start</b> A6h	-	Device select for writing
-	NoACK	9th bit Device Busy
...	...	... Device select for writing
...	...	... 9th bit Device Busy
<b>Start</b> A6h	-	Device select for writing
-	ACK	9th bit Device ready Programing completed
<b>Stop</b>	-	End of Polling

**Table 269. Byte Write in user memory when write operation is not allowed**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
<b>Start</b> A6h	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
DATA	-	Send Data
-	NoACK	9th bit: Write access not granted or FTM activated.
<b>Stop</b>	-	No Programming Device return in Standby

**B.2.2 I<sup>2</sup>C byte writing in dynamic registers and polling**
**Table 270. Byte Write in Dynamic Register (if not Read Only)**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
Dynamic Register ADDRESS_LSB	-	Send Address LSB (1 Byte) Dynamic register are located from address 2000h to 2007h , some are only readable
-	ACK	9th bit
DATA	-	Send Data
-	ACK	9th bit
Stop	-	<b>Immediate</b> update of Dynamic register

**Table 271. Polling during programming after byte write in Dynamic Register**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit Device Busy Dynamic register updates is immediate
Stop	-	End of Polling

**Table 272. Byte Write in Dynamic Register if Read Only**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit
20h	-	Send Address MSB (1 Byte)
-	NoACK	9th bit
RO Dynamic Register ADDRESS_LSB	-	Send Address LSB (1 Byte) Addresses 2001h, 2004h, 2005h and 2007h are Read Only registers.
-	ACK	9th bit
DATA	-	Send Data
-	NoACK	9th bit
Stop	-	No Programming Device return in Standby

**B.2.3 I<sup>2</sup>C byte write in mailbox and polling**
**Table 273. Byte Write in mailbox when mailbox is free from RF message and fast transfer mode is activated**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit
20h	-	Send mailbox address MSB (1 Byte)
-	ACK	9th bit
08h	-	Send Address LSB (1 Byte) Write must be done at first address of mailbox
-	ACK	9th bit
DATA	-	Send Data
-	ACK	9th bit
Stop	-	Immediate update of mailbox

**Table 274. Byte Write in mailbox when mailbox is not free from RF message fast transfer mode is not activated**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit
20h	-	Send mailbox address MSB (1 Byte)
-	ACK	9th bit
08h	-	Send Address LSB (1 Byte) Write must be done at first address of mailbox
-	ACK	9th bit
DATA	-	Send Data
-	NoACK	9th bit Access Mailbox busy or FTM not activated
Stop	-	No Programming Device return in Standby



**B.2.4 I<sup>2</sup>C byte write and polling in system memory**
**Table 275. Byte Write in System memory if I<sup>2</sup>C security session is open and register is not RO**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start AEh	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
DATA	-	Send Data
-	ACK	9th bit
Stop	-	Start of Programming

**Table 276. Polling during programing after byte write in System memory if I<sup>2</sup>C security session is open and register is not RO**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start AEh	-	Device select for writing
-	NoACK	9th bit Device Busy
Start AEh	-	Device select for writing
-	NoACK	9th bit Device Busy
Start AEh	-	Device select for writing
-	...	9th bit
Start AEh	-	Device select for writing
-	ACK	9th bit Device ready Programing completed
Stop	-	end of Polling

**Table 277. Byte Write in System memory if I<sup>2</sup>C security session is closed or register is RO**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start AEh	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
DATA	-	Send Data
-	NoACK	9th bit
Stop	-	No Programming Device return in Standby

## B.3 I<sup>2</sup>C sequential writing and polling

### B.3.1 I<sup>2</sup>C sequential write in user memory and polling

**Table 278. Sequential write User memory when write operation allowed and all bytes belong to same area**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
DATA 0	-	Send Data 0
-	ACK	9th bit
DATA 1	-	Send Data 1
-	ACK	9th bit
...	-	...
-	...	...
DATA n	-	Send Data n n ≤ 256
-	ACK	9th bit
Stop	-	Start of Programming

**Table 279. Polling during programming after sequential write in User memory when write operation allowed and all bytes belong to same area.**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	NoACK	9th bit Device Busy
Start A6h	-	Device select for writing
-	NoACK	9th bit Device Busy
Start A6h	-	Device select for writing
-	...	9th bit Device Busy
Start A6h	-	Device select for writing
-	ACK	9th bit Device ready Programing completed
Stop	-	End of Polling

**Table 280. Sequential write in User memory when write operation allowed and crossing over area border**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
DATA 0	-	Send Data 0
-	ACK	9th bit
DATA 1	-	Send Data 1
-	ACK	9th bit
...	-	...
-	...	...
DATA n	-	Send Data n Address is located in next memory area
-	NoACK	9th bit
Stop	-	No programming Device return in Standby

**Table 281. Polling during programming after sequential write in User memory when write operation allowed and crossing over area border**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit Device ready No programming
Stop	-	End of Polling

### B.3.2 I<sup>2</sup>C sequential write in mailbox and polling

**Table 282. Sequential write in mailbox when mailbox is free from RF message and fast transfer mode is activated**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send mailbox Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send mailbox Address LSB (1 Byte)
-	ACK	9th bit
DATA 0	-	Send Data 0
-	ACK	9th bit
DATA 1	-	Send Data 1
-	ACK	9th bit
...	-	...
-	...	...
DATA n	-	Send Data n n ≤ 256
-	ACK	9th bit
Stop	-	Immediate mailbox content update

**Table 283. Polling during programming after sequential write in mailbox**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit Device ready Mailbox is immediately updated
Stop	-	End of Polling

## B.4 I<sup>2</sup>C Read current address

### B.4.1 I<sup>2</sup>C current address read in User memory

**Table 284.** Current byte Read in User memory if read operation allowed (depending on area protection and RF user security session)

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A7h	-	Device select for reading
-	ACK	9th bit
	DATA	Receive Data located on last pointed address+1, or at address 0 after power-up, in user memory
NO_ACK	-	9th bit
Stop	-	End of Reading

**Table 285.** Current Read in User memory if read operation not allowed (depending on area protection and RF user security session)

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A7h	-	Device select for reading
-	ACK	9th bit
	FFh	Read of data not allowed ST25DV release SDA
NO_ACK	-	9th bit
Stop	-	End of Reading

## B.5 I<sup>2</sup>C random address read

### B.5.1 I<sup>2</sup>C random address read in user memory

**Table 286.** Random byte read in User memory if read operation allowed (depending on area protection and RF user security session)

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
Start A7h	-	Device select for reading
-	ACK	9th bit
-	DATA	Receive Data
NO_ACK	-	9th bit
Stop	-	End of Reading

**Table 287.** Random byte read in User memory if operation not allowed (depending on area protection and RF user security)

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
Start A7h	-	Device select for reading
-	ACK	9th bit
-	FFh	Read of data not allowed release SDA
NO_ACK	-	9th bit
Stop	-	End of Reading

**B.5.2 I<sup>2</sup>C Random address read in system memory**
**Table 288. Byte Read System memory (Static register or I<sup>2</sup>C Password after a valid Present I<sup>2</sup>C Password)**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
<b>Start AEh</b>	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
<b>Start AFh</b>	-	Device select for reading
-	ACK	9th bit
-	DATA	Receive Data
NO_ACK	-	9th bit
<b>Stop</b>	-	End of reading

**B.5.3 I<sup>2</sup>C Random address read in dynamic registers**
**Table 289. Random byte read in Dynamic registers**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
<b>Start A6h</b>	-	Device select for writing
-	ACK	9th bit
<b>20h</b>	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
<b>Start A7h</b>	-	Device select for reading
-	ACK	9th bit
-	DATA	Receive Data
NO_ACK	-	9th bit
<b>Stop</b>	-	End of reading

## B.6 I<sup>2</sup>C sequential read

### B.6.1 I<sup>2</sup>C sequential read in user memory

**Table 290.** Sequential Read User memory if read operation allowed (depending on area protection and RF user security session) and all bytes belong to the same area

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
Start A7h0	-	Device select for reading
-	ACK	9th bit
-	DATA 0	Receive Data 0
ACK	-	9th bit
-	DATA 1	Receive Data 1
ACK	-	9th bit
-	...	...
...	-	...
-	DATA n	Receive Data n
NO_ACK	-	9th bit
Stop	-	End of Reading



**Table 291. Sequential Read User memory if read operation allowed (depending on area protection and RF user security session) but crossing area border**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
<b>Start A6h</b>	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
<b>Start A7h</b>	-	Device select for reading
-	ACK	9th bit
-	DATA 0	Receive Data 0
ACK	-	9th bit
-	DATA 1	Receive Data 1
ACK	-	9th bit
-	...	...
...	-	...
-	DATA n	Receive Data last Address available
ACK	-	9th bit
-	FFh	Data is located in next memory area ST25DV release SDA
ACK	-	9th bit
-	...	...
...	-	...
-	FFh	Data is located in next memory area ST25DV release SDA
<b>Stop</b>	-	End of reading

**Table 292. Sequential Read User memory if read operation allowed (depending on area protection and RF user security session)**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
<b>Start</b> A6h	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
<b>Start</b> A7h	-	Device select for reading
-	ACK	9th bit
-	FFh	ST25DV release SDA Reading access not granted
ACK	-	9th bit
-	...	...
...	-	...
-	FFh	ST25DV release SDA Reading access not granted
NO_ACK	-	9th bit
<b>Stop</b>	-	End of reading

**B.6.2 I<sup>2</sup>C sequential read in system memory**
**Table 293. Sequential in Read System memory (I<sup>2</sup>C security session open if reading I2C\_PWD)**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
<b>Start AEh</b>	-	Device select for writing
-	ACK	9th bit
ADDRESS_MSB	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
<b>Start AF7h</b>	-	Device select for reading
-	ACK	9th bit
-	DATA	Receive Data 0
ACK	-	9th bit
-	DATA	Receive Data 1
ACK	-	9th bit
-	...	...
...	-	...
-	DATA	Receive Data n
NO_ACK	-	9th bit
<b>Stop</b>	-	End of Reading

**Table 294. Sequential Read system memory when access is not granted (I<sup>2</sup>C password I2C\_PWD)**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
<b>Start</b> AEh	-	Device select for writing
-	ACK	9th bit
90h	-	Send Address MSB (1 Byte)
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte)
-	ACK	9th bit
<b>Start</b> AFh	-	Device select for reading
-	ACK	9th bit
-	DATA	Receive Data 0
-	FFh	ST25DV release SDA Reading access is not granted
ACK	-	9th bit
-	...	...
...	-	...
-	FFh	ST25DV release SDA Reading access is not granted
NO_ACK	-	9th bit
<b>Stop</b>	-	End of reading

**B.6.3 I<sup>2</sup>C sequential read in dynamic registers**
**Table 295. Sequential read in dynamic register**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start A6h	-	Device select for writing
-	ACK	9th bit
20h	-	Send Address MSB (1 Byte)
-	ACK	9th bit
Dynamic register ADDRESS_LSB	-	Send Address LSB (1 Byte) Dynamic register are located form address 2000h to 2007
-	ACK	9th bit
Start A7h	-	Device select for reading
-	ACK	9th bit
-	DATA	Receive Data 0
ACK	-	9th bit
-	DATA	Receive Data 1
ACK	-	9th bit
-	...	...
...	-	...
-	Data	Receive Data n
NO_ACK	-	9th bit
Stop	-	End of reading

**Table 296. Sequential read in Dynamic register and mailbox continuously if fast transfer mode is activated**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
<b>Start</b> A6h	-	Device select for writing
-	ACK	9th bit
20h	-	Send Address MSB (1 Byte)
-	ACK	9th bit
Dynamic Register ADDRESS_LSB	-	Send Address LSB (1 Byte) Dynamic register are located from address 2000h to 2007h
-	ACK	9th bit
<b>Start</b> A7h	-	Device select for reading
-	ACK	9th bit
-	DATA 0	Receive Data 0
ACK	-	9th bit
-	DATA 1	Receive Data 1
ACK	-	9th bit
-	...	...
...	-	...
-	DATA n	Receive Data n (n ≤ 8) Last Dynamic register address 2007h
ACK	-	9th bit
-	DATA n + 1	Mailbox byte 0
ACK	-	9th bit
-	DATA n + 2	Mailbox byte 1
ACK	-	9th bit
-	...	...
...	-	...
-	Data n + i	Mailbox byte i (i < 256)
NO_ACK	-	9th bit
<b>Stop</b>	-	End of reading

**B.6.4 I<sup>2</sup>C sequential read in mailbox**
**Table 297. Sequential in mailbox if fast transfer mode is activated**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
<b>Start</b> A6h	-	Device select for writing
-	ACK	9th bit
20h or 21h	-	Send Address MSB (1 Byte) 2007h < @ 2108h
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte) 2007h < @ 2108h
-	ACK	9th bit
<b>Start</b> A7h	-	Device select for reading
-	ACK	9th bit
-	DATA 0	Receive Data 0
ACK	-	9th bit
-	DATA 1	Receive Data 1
ACK	-	9th bit
-	...	...
...	-	...
-	Data n	Receive Data n
NO_ACK	-	9th bit
<b>Stop</b>	-	End of reading

**Table 298. Sequential read in mailbox if fast transfer mode is not activated**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
<b>Start</b> A6h	-	Device select for writing
-	ACK	9th bit
20h or 21h	-	Send Address MSB (1 Byte) 2007h < @ 2108h
-	ACK	9th bit
ADDRESS_LSB	-	Send Address LSB (1 Byte) 2007h < @ 2108h
-	ACK	9th bit
<b>Start</b> A7h	-	Device select for reading
-	ACK	9th bit
-	FFh	release SDA
ACK	-	9th bit
-	FFh	release SDA
ACK	-	9th bit
-	...	...
...	-	...
-	FFh	release SDA
NO_ACK	-	9th bit
<b>Stop</b>	-	End of reading



## B.7 I<sup>2</sup>C password relative sequences

### B.7.1 I<sup>2</sup>C write password

**Table 299.** Write Password when I<sup>2</sup>C security session is already open and fast transfer mode is not activated

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
Start AEh	-	Device select for writing
-	ACK	9th bit
09h	-	Send I2C_PWD MSB address
-	ACK	9th bit
00h	-	Send I2C_PWD LSB address
-	ACK	9th bit
I2C_PWD_BYTE_7	-	Send I2C_PWD MSB
-	ACK	9th bit
I2C_PWD_BYTE_6	DATA 0	Send Data
-	ACK	9th bit
...	-	...
-	...	...
I2C_PWD_BYTE_0	-	Send I2C_PWD LSB
-	ACK	9th bit
07h	-	Write password command
-	ACK	9th bit
I2C_PWD_BYTE_7	-	Send I2C_PWD MSB
-	ACK	9th bit
I2C_PWD_BYTE_6	DATA 0	Send Data
-	ACK	9th bit
...	-	...
-	...	...
I2C_PWD_BYTE_0	-	Send I2C_PWD LSB
-	ACK	9th bit
Stop	-	Start of I <sup>2</sup> C password programming

**Table 300. Write Password when I<sup>2</sup>C security session is not open or fast transfer mode activated**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
<b>Start</b> AEh	-	Device select for writing
-	ACK	9th bit
09h	-	Send I2C_PWD MSB address
-	ACK	9th bit
00h	-	Send I2C_PWD LSB address
-	NoACK	9th bit
<b>Stop</b>	-	No PWD Programming Device return in Standby

**B.7.2 I<sup>2</sup>C present password**
**Table 301. Present Password (whatever status of I<sup>2</sup>C security session or fast transfer mode)**

Request/Response Frame		Comment
Master drives SDA	Slave drives SDA	
<b>Start AEh</b>	-	Device select for writing
-	ACK	9th bit
09h	-	Send I2C_PWD MSB address
-	ACK	9th bit
00h	-	Send I2C_PWD LSB address
-	ACK	9th bit
I2C_PWD_BYTE_7	-	Send I2C_PWD MSB
-	ACK	9th bit
I2C_PWD_BYTE_6	DATA 0	Send Data
-	ACK	9th bit
...	-	...
-	...	...
I2C_PWD_BYTE_0	-	Send I2C_PWD LSB
-	ACK	9th bit
09h	-	Present password command
-	ACK	9th bit
I2C_PWD_BYTE_7	-	Send I2C_PWD MSB
-	ACK	9th bit
I2C_PWD_BYTE_6	-	Send Data
-	ACK	9th bit
...	-	...
-	...	...
I2C_PWD_BYTE_0	-	Send I2C_PWD LSB
-	ACK	9th bit
<b>Stop</b>	-	ST25DV with active I2C_PWD. Result is immediate.

## Revision history

**Table 302. Document revision history**

Date	Revision	Changes
23-Jun-2021	1	Initial release.
22-Jul-2021	2	Modified the title of the document.
09-Feb-2022	3	Added WLCSP10 package Updated: <ul style="list-style-type: none"> <li>• Features</li> <li>• Section 1.1 ST25DVxxKC block diagram</li> <li>• Section 1.2 ST25DVxxKC packaging</li> <li>• Section 2.2.2 Low power down (LPD)</li> <li>• Section 2.4.1 Driver supply voltage (VDCG)</li> <li>• Section 2.4.2 General purpose output (GPO)</li> </ul>

## Contents

<b>1</b>	<b>Description</b> .....	<b>3</b>
1.1	ST25DVxxKC block diagram .....	3
1.2	ST25DVxxKC packaging .....	4
<b>2</b>	<b>Signal descriptions</b> .....	<b>7</b>
2.1	Serial link (SCL, SDA) .....	7
2.1.1	Serial clock (SCL) .....	7
2.1.2	Serial data (SDA) .....	7
2.2	Power control ( $V_{CC}$ , LPD, $V_{SS}$ ) .....	7
2.2.1	Supply voltage ( $V_{CC}$ ) .....	7
2.2.2	Low power down (LPD) .....	7
2.2.3	Ground ( $V_{SS}$ ) .....	7
2.3	RF link (AC0 AC1) .....	8
2.3.1	Antenna coil (AC0, AC1) .....	8
2.4	Process control (VDCG, GPO) .....	8
2.4.1	Driver supply voltage ( $V_{DCG}$ ) .....	8
2.4.2	General purpose output (GPO) .....	8
2.5	Energy harvesting analog output ( $V_{EH}$ ) .....	8
<b>3</b>	<b>Power management</b> .....	<b>9</b>
3.1	Wired interface .....	9
3.2	Contactless interface .....	10
<b>4</b>	<b>Memory management</b> .....	<b>11</b>
4.1	Memory organization overview .....	11
4.2	User memory .....	12
4.2.1	User memory areas .....	14
4.3	System configuration area .....	18
4.4	Dynamic configuration .....	20
4.5	Fast transfer mode mailbox .....	21
<b>5</b>	<b>ST25DVxxKC specific features</b> .....	<b>22</b>
5.1	Fast transfer mode (FTM) .....	23
5.1.1	Fast transfer mode registers .....	23

5.1.2	Fast transfer mode usage .....	24
<b>5.2</b>	<b>RF management feature .....</b>	<b>28</b>
5.2.1	RF management registers .....	28
5.2.2	RF management feature description .....	29
<b>5.3</b>	<b>Interface arbitration .....</b>	<b>31</b>
5.3.1	Interface Arbitration .....	32
<b>5.4</b>	<b>GPO .....</b>	<b>33</b>
5.4.1	ST25DVxxKC interrupt capabilities on RF events .....	33
5.4.2	ST25DVxxKC interrupt capabilities on I <sup>2</sup> C events .....	41
5.4.3	GPO and power supply .....	42
5.4.4	GPO registers .....	43
5.4.5	Configuring GPO .....	47
<b>5.5</b>	<b>Energy harvesting (EH) .....</b>	<b>48</b>
5.5.1	Energy harvesting registers .....	48
5.5.2	Energy harvesting feature description .....	49
5.5.3	EH delivery state diagram .....	50
5.5.4	EH delivery sequence .....	51
<b>5.6</b>	<b>Data protection .....</b>	<b>51</b>
5.6.1	Data protection registers .....	51
5.6.2	Passwords and security sessions .....	58
5.6.3	User memory protection .....	61
5.6.4	System memory protection .....	62
<b>5.7</b>	<b>Device parameter registers .....</b>	<b>63</b>
<b>6</b>	<b>I<sup>2</sup>C operation .....</b>	<b>67</b>
<b>6.1</b>	<b>I<sup>2</sup>C protocol .....</b>	<b>67</b>
6.1.1	Start condition .....	67
6.1.2	Stop condition .....	68
6.1.3	Acknowledge bit (ACK) .....	68
6.1.4	Data input .....	68
<b>6.2</b>	<b>I<sup>2</sup>C timeout .....</b>	<b>68</b>
6.2.1	I <sup>2</sup> C timeout on Start condition .....	68
6.2.2	I <sup>2</sup> C timeout on clock period .....	68

<b>6.3</b>	Device addressing . . . . .	69
<b>6.4</b>	I <sup>2</sup> C Write operations . . . . .	70
<b>6.4.1</b>	I <sup>2</sup> C Byte write . . . . .	70
<b>6.4.2</b>	I <sup>2</sup> C Sequential write . . . . .	71
<b>6.4.3</b>	Minimizing system delays by polling on ACK . . . . .	72
<b>6.5</b>	I <sup>2</sup> C read operations . . . . .	73
<b>6.5.1</b>	Random address read . . . . .	74
<b>6.5.2</b>	Current address read . . . . .	74
<b>6.5.3</b>	Sequential read access . . . . .	74
<b>6.5.4</b>	Acknowledge in read mode . . . . .	75
<b>6.6</b>	I <sup>2</sup> C password management . . . . .	75
<b>6.6.1</b>	I <sup>2</sup> C present password command description . . . . .	75
<b>6.6.2</b>	I <sup>2</sup> C write password command description . . . . .	76
<b>7</b>	<b>RF operations . . . . .</b>	<b>77</b>
<b>7.1</b>	RF communication . . . . .	77
<b>7.1.1</b>	Access to a ISO/IEC 15693 device . . . . .	77
<b>7.2</b>	RF communication and energy harvesting . . . . .	77
<b>7.3</b>	Fast transfer mode mailbox access in RF . . . . .	77
<b>7.4</b>	RF protocol description . . . . .	78
<b>7.4.1</b>	Protocol description . . . . .	78
<b>7.4.2</b>	ST25DVxxKC states referring to RF protocol . . . . .	78
<b>7.4.3</b>	Modes . . . . .	80
<b>7.4.4</b>	Request format . . . . .	80
<b>7.4.5</b>	Request flags . . . . .	80
<b>7.4.6</b>	Response format . . . . .	82
<b>7.4.7</b>	Response flags . . . . .	82
<b>7.4.8</b>	Response and error code . . . . .	82
<b>7.5</b>	Timing definition . . . . .	83
<b>7.6</b>	RF commands . . . . .	85
<b>7.6.1</b>	RF command code list . . . . .	85
<b>7.6.2</b>	Command codes list . . . . .	85
<b>7.6.3</b>	General command rules . . . . .	86

<b>7.6.4</b>	Inventory . . . . .	87
<b>7.6.5</b>	Stay Quiet . . . . .	87
<b>7.6.6</b>	Read Single Block . . . . .	88
<b>7.6.7</b>	Extended Read Single Block . . . . .	89
<b>7.6.8</b>	Write Single Block . . . . .	90
<b>7.6.9</b>	Extended Write Single Block . . . . .	92
<b>7.6.10</b>	Lock Block . . . . .	93
<b>7.6.11</b>	Extended Lock block . . . . .	94
<b>7.6.12</b>	Read Multiple Blocks . . . . .	95
<b>7.6.13</b>	Extended Read Multiple Blocks . . . . .	97
<b>7.6.14</b>	Write Multiple Blocks . . . . .	98
<b>7.6.15</b>	Extended Write Multiple Blocks . . . . .	99
<b>7.6.16</b>	Select . . . . .	101
<b>7.6.17</b>	Reset to Ready . . . . .	102
<b>7.6.18</b>	Write AFI . . . . .	103
<b>7.6.19</b>	Lock AFI . . . . .	104
<b>7.6.20</b>	Write DSFID . . . . .	105
<b>7.6.21</b>	Lock DSFID . . . . .	106
<b>7.6.22</b>	Get System Info . . . . .	108
<b>7.6.23</b>	Extended Get System Info . . . . .	109
<b>7.6.24</b>	Get Multiple Block Security Status . . . . .	113
<b>7.6.25</b>	Extended Get Multiple Block Security Status . . . . .	115
<b>7.6.26</b>	Read Configuration . . . . .	117
<b>7.6.27</b>	Write Configuration . . . . .	118
<b>7.6.28</b>	Read Dynamic Configuration . . . . .	119
<b>7.6.29</b>	Write Dynamic Configuration . . . . .	120
<b>7.6.30</b>	Manage GPO . . . . .	121
<b>7.6.31</b>	Write Message . . . . .	122
<b>7.6.32</b>	Read Message Length . . . . .	123
<b>7.6.33</b>	Read Message . . . . .	124
<b>7.6.34</b>	Fast Read Message . . . . .	125
<b>7.6.35</b>	Write Password . . . . .	126
<b>7.6.36</b>	Present Password . . . . .	128



7.6.37	Fast Read Single Block . . . . .	129
7.6.38	Fast Extended Read Single Block . . . . .	130
7.6.39	Fast Read Multiple Blocks . . . . .	132
7.6.40	Fast Extended Read Multiple Block . . . . .	133
7.6.41	Fast Write Message . . . . .	134
7.6.42	Fast Read Message Length . . . . .	136
7.6.43	Fast Read Dynamic Configuration . . . . .	137
7.6.44	Fast Write Dynamic Configuration . . . . .	138
<b>8</b>	<b>Unique identifier (UID) . . . . .</b>	<b>140</b>
<b>9</b>	<b>Device parameters . . . . .</b>	<b>141</b>
9.1	Maximum rating . . . . .	141
9.2	I <sup>2</sup> C DC and AC parameters . . . . .	142
9.3	GPO characteristics . . . . .	149
9.4	RF electrical parameters . . . . .	150
9.5	Thermal characteristics . . . . .	151
<b>10</b>	<b>Package information . . . . .</b>	<b>152</b>
10.1	SO8N package information . . . . .	152
10.2	TSSOP8 package information . . . . .	154
10.3	UFDFN8 package information . . . . .	156
10.4	WLCSP10 package information . . . . .	158
10.5	UFDFPN12 package information . . . . .	160
<b>11</b>	<b>Ordering information . . . . .</b>	<b>161</b>
<b>Appendix A</b>	<b>Bit representation and coding for fast commands . . . . .</b>	<b>162</b>
A.1	Bit coding using one subcarrier . . . . .	162
A.1.1	High data rate . . . . .	162
A.1.2	Low data rate . . . . .	162
A.2	ST25DVxxKC to VCD frames . . . . .	163
A.3	SOF when using one subcarrier . . . . .	163
A.3.1	High data rate . . . . .	163
A.3.2	Low data rate . . . . .	163
A.4	EOF when using one subcarrier . . . . .	164

<b>A.4.1</b>	High data rate .....	164
<b>A.4.2</b>	Low data rate .....	164
<b>Appendix B</b>	<b>I<sup>2</sup>C sequences .....</b>	<b>165</b>
<b>B.1</b>	Device select codes .....	165
<b>B.2</b>	I <sup>2</sup> C Byte writing and polling .....	165
<b>B.2.1</b>	I <sup>2</sup> C byte write in user memory .....	165
<b>B.2.2</b>	I <sup>2</sup> C byte writing in dynamic registers and polling .....	167
<b>B.2.3</b>	I <sup>2</sup> C byte write in mailbox and polling .....	168
<b>B.2.4</b>	I <sup>2</sup> C byte write and polling in system memory .....	169
<b>B.3</b>	I <sup>2</sup> C sequential writing and polling .....	170
<b>B.3.1</b>	I <sup>2</sup> C sequential write in user memory and polling .....	170
<b>B.3.2</b>	I <sup>2</sup> C sequential write in mailbox and polling .....	172
<b>B.4</b>	I <sup>2</sup> C Read current address .....	173
<b>B.4.1</b>	I <sup>2</sup> C current address read in User memory .....	173
<b>B.5</b>	I <sup>2</sup> C random address read .....	174
<b>B.5.1</b>	I <sup>2</sup> C random address read in user memory .....	174
<b>B.5.2</b>	I <sup>2</sup> C Random address read in system memory .....	175
<b>B.5.3</b>	I <sup>2</sup> C Random address read in dynamic registers .....	175
<b>B.6</b>	I <sup>2</sup> C sequential read .....	176
<b>B.6.1</b>	I <sup>2</sup> C sequential read in user memory .....	176
<b>B.6.2</b>	I <sup>2</sup> C sequential read in system memory .....	179
<b>B.6.3</b>	I <sup>2</sup> C sequential read in dynamic registers .....	181
<b>B.6.4</b>	I <sup>2</sup> C sequential read in mailbox .....	183
<b>B.7</b>	I <sup>2</sup> C password relative sequences .....	185
<b>B.7.1</b>	I <sup>2</sup> C write password .....	185
<b>B.7.2</b>	I <sup>2</sup> C present password .....	187
<b>Revision history</b> .....		<b>188</b>

## List of tables

<b>Table 1.</b>	8-pin packages signal names . . . . .	4
<b>Table 2.</b>	10-pin packages signal names. . . . .	5
<b>Table 3.</b>	12-pin packages signal names. . . . .	6
<b>Table 4.</b>	User memory as seen by RF and by I <sup>2</sup> C . . . . .	13
<b>Table 5.</b>	Maximum user memory block and byte addresses and ENDA <sub>i</sub> value. . . . .	15
<b>Table 6.</b>	Areas and limit calculation from ENDA <sub>i</sub> registers . . . . .	15
<b>Table 7.</b>	END A1 access . . . . .	17
<b>Table 8.</b>	END A1 . . . . .	17
<b>Table 9.</b>	END A2 access . . . . .	17
<b>Table 10.</b>	END A2 . . . . .	17
<b>Table 11.</b>	END A3 access . . . . .	17
<b>Table 12.</b>	END A3 . . . . .	18
<b>Table 13.</b>	System configuration memory map . . . . .	18
<b>Table 14.</b>	Dynamic registers memory map. . . . .	20
<b>Table 15.</b>	Fast transfer mode mailbox memory map . . . . .	21
<b>Table 16.</b>	FTM access . . . . .	23
<b>Table 17.</b>	FTM. . . . .	23
<b>Table 18.</b>	MB_CTRL_Dyn access. . . . .	23
<b>Table 19.</b>	MB_CTRL_Dyn . . . . .	24
<b>Table 20.</b>	MB_LEN_Dyn access. . . . .	24
<b>Table 21.</b>	MB_LEN_Dyn . . . . .	24
<b>Table 22.</b>	RF_MNGT access . . . . .	28
<b>Table 23.</b>	RF_MNGT . . . . .	28
<b>Table 24.</b>	RF_MNGT_Dyn access . . . . .	28
<b>Table 25.</b>	RF_MNGT_Dyn. . . . .	28
<b>Table 26.</b>	RF modes summary. . . . .	30
<b>Table 27.</b>	RF modes configuration bits and effect on RF requests. . . . .	30
<b>Table 28.</b>	FIELD_CHANGE when RF is disabled or in sleep of off mode . . . . .	37
<b>Table 29.</b>	GPO interrupt capabilities in function of RF field and V <sub>CC</sub> . . . . .	43
<b>Table 30.</b>	GPO1 access . . . . .	43
<b>Table 31.</b>	GPO1. . . . .	44
<b>Table 32.</b>	GPO2 access . . . . .	44
<b>Table 33.</b>	GPO2. . . . .	45
<b>Table 34.</b>	GPO_CTRL_Dyn access . . . . .	45
<b>Table 35.</b>	GPO_CTRL_Dyn. . . . .	45
<b>Table 36.</b>	IT_STS_Dyn access. . . . .	45
<b>Table 37.</b>	IT_STS_Dyn . . . . .	46
<b>Table 38.</b>	Enabling or disabling GPO interruptions . . . . .	47
<b>Table 39.</b>	EH_MODE access. . . . .	48
<b>Table 40.</b>	EH_MODE . . . . .	48
<b>Table 41.</b>	EH_CTRL_Dyn access. . . . .	48
<b>Table 42.</b>	EH_CTRL_Dyn . . . . .	48
<b>Table 43.</b>	Energy harvesting at power-up . . . . .	49
<b>Table 44.</b>	RFA1SS access. . . . .	51
<b>Table 45.</b>	RFA1SS . . . . .	52
<b>Table 46.</b>	RFA2SS access. . . . .	52
<b>Table 47.</b>	RFA2SS . . . . .	52
<b>Table 48.</b>	RFA3SS access. . . . .	52
<b>Table 49.</b>	RFA3SS . . . . .	53
<b>Table 50.</b>	RFA4SS access. . . . .	53
<b>Table 51.</b>	RFA4SS . . . . .	53
<b>Table 52.</b>	I2CSS access . . . . .	54

<b>Table 53.</b>	I2CSS	54
<b>Table 54.</b>	LOCK_CCFILE access	55
<b>Table 55.</b>	LOCK_CCFILE	55
<b>Table 56.</b>	LOCK_CFG access	55
<b>Table 57.</b>	LOCK_CFG	55
<b>Table 58.</b>	I2C_PWD access	56
<b>Table 59.</b>	I2C_PWD	56
<b>Table 60.</b>	RF_PWD_0 access	56
<b>Table 61.</b>	RF_PWD_0	56
<b>Table 62.</b>	RF_PWD_1 access	57
<b>Table 63.</b>	RF_PWD_1	57
<b>Table 64.</b>	RF_PWD_2 access	57
<b>Table 65.</b>	RF_PWD_2	57
<b>Table 66.</b>	RF_PWD_3 access	58
<b>Table 67.</b>	RF_PWD_3	58
<b>Table 68.</b>	I2C_SSO_Dyn access	58
<b>Table 69.</b>	I2C_SSO_Dyn	58
<b>Table 70.</b>	Security session type	59
<b>Table 71.</b>	LOCK_DSFD access	63
<b>Table 72.</b>	LOCK_DSFD	63
<b>Table 73.</b>	LOCK_AFI access	63
<b>Table 74.</b>	LOCK_AFI	63
<b>Table 75.</b>	DSFID access	64
<b>Table 76.</b>	DSFID	64
<b>Table 77.</b>	AFI access	64
<b>Table 78.</b>	AFI	64
<b>Table 79.</b>	MEM_SIZE access	64
<b>Table 80.</b>	MEM_SIZE	65
<b>Table 81.</b>	BLK_SIZE access	65
<b>Table 82.</b>	BLK_SIZE	65
<b>Table 83.</b>	IC_REF access	65
<b>Table 84.</b>	IC_REF	65
<b>Table 85.</b>	UID access	66
<b>Table 86.</b>	UID	66
<b>Table 87.</b>	IC_REV access	66
<b>Table 88.</b>	IC_REV	66
<b>Table 89.</b>	Device select code	69
<b>Table 90.</b>	I2C_CFG access	69
<b>Table 91.</b>	I2C_CFG	69
<b>Table 92.</b>	Operating modes	70
<b>Table 93.</b>	Address most significant byte	70
<b>Table 94.</b>	Address least significant byte	70
<b>Table 95.</b>	ST25DVxxKC response depending on Request_flags	79
<b>Table 96.</b>	General request format	80
<b>Table 97.</b>	Definition of request flags 1 to 4	81
<b>Table 98.</b>	Request flags 5 to 8 when inventory_flag, Bit 3 = 0	81
<b>Table 99.</b>	Request flags 5 to 8 when inventory_flag, Bit 3 = 1	81
<b>Table 100.</b>	General response format	82
<b>Table 101.</b>	Definitions of response flags 1 to 8	82
<b>Table 102.</b>	Response error code definition	83
<b>Table 103.</b>	Timing values	84
<b>Table 104.</b>	Command codes	86
<b>Table 105.</b>	Inventory request format	87
<b>Table 106.</b>	Inventory response format	87

<b>Table 107.</b>	Stay Quiet request format . . . . .	88
<b>Table 108.</b>	Read Single Block request format . . . . .	88
<b>Table 109.</b>	Read Single Block response format when Error_flag is NOT set. . . . .	88
<b>Table 110.</b>	Block security status. . . . .	89
<b>Table 111.</b>	Read Single Block response format when Error_flag is set . . . . .	89
<b>Table 112.</b>	Extended Read Single Block request format . . . . .	89
<b>Table 113.</b>	Extended Read Single Block response format when Error_flag is NOT set . . . . .	90
<b>Table 114.</b>	Block security status. . . . .	90
<b>Table 115.</b>	Extended Read Single Block response format when Error_flag is set . . . . .	90
<b>Table 116.</b>	Write Single Block request format . . . . .	91
<b>Table 117.</b>	Write Single Block response format when Error_flag is NOT set. . . . .	91
<b>Table 118.</b>	Write Single Block response format when Error_flag is set . . . . .	91
<b>Table 119.</b>	Extended Write Single request format. . . . .	92
<b>Table 120.</b>	Extended Write Single response format when Error_flag is NOT set . . . . .	92
<b>Table 121.</b>	Extended Write Single response format when Error_flag is set. . . . .	92
<b>Table 122.</b>	Lock block request format . . . . .	93
<b>Table 123.</b>	Lock block response format when Error_flag is NOT set . . . . .	93
<b>Table 124.</b>	Lock block response format when Error_flag is set. . . . .	93
<b>Table 125.</b>	Extended Lock block request format. . . . .	94
<b>Table 126.</b>	Extended Lock block response format when Error_flag is NOT set . . . . .	94
<b>Table 127.</b>	Extended Lock block response format when Error_flag is set. . . . .	95
<b>Table 128.</b>	Read Multiple Block request format . . . . .	95
<b>Table 129.</b>	Read Multiple Block response format when Error_flag is NOT set . . . . .	96
<b>Table 130.</b>	Block security status. . . . .	96
<b>Table 131.</b>	Read Multiple Block response format when Error_flag is set . . . . .	96
<b>Table 132.</b>	Extended Read Multiple Block request format . . . . .	97
<b>Table 133.</b>	Extended Read Multiple Block response format when Error_flag is NOT set . . . . .	97
<b>Table 134.</b>	Block security status. . . . .	97
<b>Table 135.</b>	Extended Read Multiple Block response format when Error_flag is set . . . . .	97
<b>Table 136.</b>	Write Multiple Block request format . . . . .	98
<b>Table 137.</b>	Write Multiple Block response format when Error_flag is NOT set. . . . .	99
<b>Table 138.</b>	Write Multiple Block response format when Error_flag is set . . . . .	99
<b>Table 139.</b>	Extended Write Multiple Block request format . . . . .	100
<b>Table 140.</b>	Extended Write Multiple Block response format when Error_flag is NOT set . . . . .	100
<b>Table 141.</b>	Extended Write Multiple Block response format when Error_flag is set . . . . .	100
<b>Table 142.</b>	Select request format . . . . .	101
<b>Table 143.</b>	Select Block response format when Error_flag is NOT set . . . . .	101
<b>Table 144.</b>	Select response format when Error_flag is set. . . . .	101
<b>Table 145.</b>	Reset to Ready request format . . . . .	102
<b>Table 146.</b>	Reset to Ready response format when Error_flag is NOT set. . . . .	102
<b>Table 147.</b>	Reset to ready response format when Error_flag is set . . . . .	102
<b>Table 148.</b>	Write AFI request format . . . . .	103
<b>Table 149.</b>	Write AFI response format when Error_flag is NOT set . . . . .	103
<b>Table 150.</b>	Write AFI response format when Error_flag is set. . . . .	103
<b>Table 151.</b>	Lock AFI request format . . . . .	104
<b>Table 152.</b>	Lock AFI response format when Error_flag is NOT set . . . . .	104
<b>Table 153.</b>	Lock AFI response format when Error_flag is set . . . . .	105
<b>Table 154.</b>	Write DSFID request format . . . . .	105
<b>Table 155.</b>	Write DSFID response format when Error_flag is NOT set. . . . .	105
<b>Table 156.</b>	Write DSFID response format when Error_flag is set . . . . .	106
<b>Table 157.</b>	Lock DSFID request format . . . . .	106
<b>Table 158.</b>	Lock DSFID response format when Error_flag is NOT set . . . . .	107
<b>Table 159.</b>	Lock DSFID response format when Error_flag is set. . . . .	107
<b>Table 160.</b>	Get System Info request format . . . . .	108

<b>Table 161.</b>	Get System Info response format Error_flag is NOT set	108
<b>Table 162.</b>	Memory size	108
<b>Table 163.</b>	Get System Info response format when Error_flag is set	108
<b>Table 164.</b>	Extended Get System Info request format	109
<b>Table 165.</b>	Parameter request list	110
<b>Table 166.</b>	Extended Get System Info response format when Error_flag is NOT set	110
<b>Table 167.</b>	Response Information Flag	111
<b>Table 168.</b>	Response other field: ST25DVxxKC VICC memory size	111
<b>Table 169.</b>	Response other field: ST25DVxxKC IC Ref	111
<b>Table 170.</b>	Response other field: ST25DVxxKC VICC command list	111
<b>Table 171.</b>	Response other field: ST25DVxxKC VICC command list Byte 1	112
<b>Table 172.</b>	Response other field: ST25DVxxKC VICC command list Byte 2	112
<b>Table 173.</b>	Response other field: ST25DVxxKC VICC command list Byte 3	112
<b>Table 174.</b>	Response other field: ST25DVxxKC VICC command list Byte 4	113
<b>Table 175.</b>	Extended Get System Info response format when Error_flag is set	113
<b>Table 176.</b>	Get Multiple Block Security Status request format	114
<b>Table 177.</b>	Get Multiple Block Security Status response format when Error_flag is NOT set	114
<b>Table 178.</b>	Block security status	114
<b>Table 179.</b>	Get Multiple Block Security Status response format when Error_flag is set	114
<b>Table 180.</b>	Extended Get Multiple Block Security Status request format	115
<b>Table 181.</b>	Extended Get Multiple Block Security Status response format when Error_flags NOT set	115
<b>Table 182.</b>	Block security status	115
<b>Table 183.</b>	Extended Get Multiple Block Security Status response format when Error_flag is set	115
<b>Table 184.</b>	Read Configuration request format	117
<b>Table 185.</b>	Read Configuration response format when Error_flag is NOT set	117
<b>Table 186.</b>	Read Configuration response format when Error_flag is set	117
<b>Table 187.</b>	Write Configuration request format	118
<b>Table 188.</b>	Write Configuration response format when Error_flag is NOT set	118
<b>Table 189.</b>	Write configuration response format when Error_flag is set	118
<b>Table 190.</b>	Read Dynamic Configuration request format	119
<b>Table 191.</b>	Read Dynamic Configuration response format when Error_flag is NOT set	119
<b>Table 192.</b>	Read Dynamic Configuration response format when Error_flag is set	119
<b>Table 193.</b>	Write Dynamic Configuration request format	120
<b>Table 194.</b>	Write Dynamic Configuration response format when Error_flag is NOT set	120
<b>Table 195.</b>	Write Dynamic Configuration response format when Error_flag is set	120
<b>Table 196.</b>	Manage GPO request format	121
<b>Table 197.</b>	GPOVAL	121
<b>Table 198.</b>	Manage GPO response format when Error_flag is NOT set	122
<b>Table 199.</b>	ManageGPO response format when Error_flag is set	122
<b>Table 200.</b>	Write Message request format	122
<b>Table 201.</b>	Write Message response format when Error_flag is NOT set	123
<b>Table 202.</b>	Write Message response format when Error_flag is set	123
<b>Table 203.</b>	Read Message Length request format	124
<b>Table 204.</b>	Read Message Length response format when Error_flag is NOT set	124
<b>Table 205.</b>	Read Message Length response format when Error_flag is set	124
<b>Table 206.</b>	Read Message request format	125
<b>Table 207.</b>	Read Message response format when Error_flag is NOT set	125
<b>Table 208.</b>	Fast Read Message request format	126
<b>Table 209.</b>	Fast Read Message response format when Error_flag is NOT set	126
<b>Table 210.</b>	Write Password request format	127
<b>Table 211.</b>	Write Password response format when Error_flag is NOT set	127
<b>Table 212.</b>	Write Password response format when Error_flag is set	127
<b>Table 213.</b>	Present Password request format	128
<b>Table 214.</b>	Present Password response format when Error_flag is NOT set	128

<b>Table 215.</b>	Present Password response format when Error_flag is set . . . . .	129
<b>Table 216.</b>	Fast Read Single Block request format . . . . .	129
<b>Table 217.</b>	Fast Read Single Block response format when Error_flag is NOT set . . . . .	129
<b>Table 218.</b>	Block security status. . . . .	130
<b>Table 219.</b>	Fast Read Single Block response format when Error_flag is set . . . . .	130
<b>Table 220.</b>	Fast Extended Read Single Block request format. . . . .	130
<b>Table 221.</b>	Fast Extended Read Single Block response format when Error_flag is NOT set . . . . .	131
<b>Table 222.</b>	Block security status. . . . .	131
<b>Table 223.</b>	Fast Extended Read Single Block response format when Error_flag is set. . . . .	131
<b>Table 224.</b>	Fast Read Multiple Block request format . . . . .	132
<b>Table 225.</b>	Fast Read Multiple Block response format when Error_flag is NOT set . . . . .	132
<b>Table 226.</b>	Block security status if Option_flag is set. . . . .	132
<b>Table 227.</b>	Fast Read Multiple Block response format when Error_flag is set . . . . .	132
<b>Table 228.</b>	Fast Extended Read Multiple Block request format. . . . .	133
<b>Table 229.</b>	Fast Extended Read Multiple Block response format when Error_flag is NOT set . . . . .	134
<b>Table 230.</b>	Block security status if Option_flag is set. . . . .	134
<b>Table 231.</b>	Fast Read Multiple Block response format when Error_flag is set . . . . .	134
<b>Table 232.</b>	Fast Write Message request format . . . . .	135
<b>Table 233.</b>	Fast Write Message response format when Error_flag is NOT set . . . . .	135
<b>Table 234.</b>	Fast Write Message response format when Error_flag is set . . . . .	135
<b>Table 235.</b>	Fast Read Message Length request format . . . . .	136
<b>Table 236.</b>	Fast Read Message Length response format when Error_flag is NOT set . . . . .	136
<b>Table 237.</b>	Fast Read Message Length response format when Error_flag is set . . . . .	136
<b>Table 238.</b>	Fast Read Dynamic configuration request format . . . . .	137
<b>Table 239.</b>	Fast Read Dynamic configuration response format when Error_flag is NOT set . . . . .	137
<b>Table 240.</b>	Fast Read Dynamic configuration response format when Error_flag is set . . . . .	137
<b>Table 241.</b>	Fast Write Dynamic Configuration request format. . . . .	138
<b>Table 242.</b>	Fast Write Dynamic Configuration response format when Error_flag is NOT set . . . . .	138
<b>Table 243.</b>	Fast Write Dynamic Configuration response format when Error_flag is set. . . . .	139
<b>Table 244.</b>	UID format . . . . .	140
<b>Table 245.</b>	Absolute maximum ratings . . . . .	141
<b>Table 246.</b>	I <sup>2</sup> C operating conditions . . . . .	142
<b>Table 247.</b>	AC test measurement conditions . . . . .	142
<b>Table 248.</b>	Input parameters . . . . .	142
<b>Table 249.</b>	I <sup>2</sup> C DC characteristics up to 85 °C . . . . .	143
<b>Table 250.</b>	I <sup>2</sup> C DC characteristics up to 125 °C . . . . .	144
<b>Table 251.</b>	I <sup>2</sup> C AC characteristics up to 85 °C . . . . .	146
<b>Table 252.</b>	I <sup>2</sup> C AC characteristics up to 125 °C . . . . .	147
<b>Table 253.</b>	GPO DC characteristics up to 85 °C . . . . .	149
<b>Table 254.</b>	GPO DC characteristics up to 125 °C . . . . .	149
<b>Table 255.</b>	GPO AC characteristics . . . . .	149
<b>Table 256.</b>	RF characteristics . . . . .	150
<b>Table 257.</b>	Operating conditions . . . . .	151
<b>Table 258.</b>	Thermal characteristics. . . . .	151
<b>Table 259.</b>	SO8N – Mechanical data . . . . .	153
<b>Table 260.</b>	TSSOP8 – Mechanical data . . . . .	154
<b>Table 261.</b>	UFDFN8 - Mechanical data . . . . .	157
<b>Table 262.</b>	WLCSP - 10 balls, 1.649x1.483 mm, 0.4 mm pitch, wafer level chip scale mechanical data . . . . .	158
<b>Table 263.</b>	WLCSP10 recommended PCB design rules . . . . .	159
<b>Table 264.</b>	UFDFPN12 - Mechanical data . . . . .	160
<b>Table 265.</b>	Ordering information scheme. . . . .	161
<b>Table 266.</b>	Device select usage . . . . .	165
<b>Table 267.</b>	Byte Write in user memory when write operation allowed . . . . .	165
<b>Table 268.</b>	Polling during programming after byte writing in user memory . . . . .	166

<b>Table 269.</b>	Byte Write in user memory when write operation is not allowed . . . . .	166
<b>Table 270.</b>	Byte Write in Dynamic Register (if not Read Only) . . . . .	167
<b>Table 271.</b>	Polling during programming after byte write in Dynamic Register . . . . .	167
<b>Table 272.</b>	Byte Write in Dynamic Register if Read Only . . . . .	167
<b>Table 273.</b>	Byte Write in mailbox when mailbox is free from RF message and fast transfer mode is activated . . . . .	168
<b>Table 274.</b>	Byte Write in mailbox when mailbox is not free from RF message fast transfer mode is not activated . . . . .	168
<b>Table 275.</b>	Byte Write in System memory if I <sup>2</sup> C security session is open and register is not RO . . . . .	169
<b>Table 276.</b>	Polling during programing after byte write in System memory if I <sup>2</sup> C security session is open and register is not RO . . . . .	169
<b>Table 277.</b>	Byte Write in System memory if I <sup>2</sup> C security session is closed or register is RO . . . . .	170
<b>Table 278.</b>	Sequential write User memory when write operation allowed and all bytes belong to same area . . . . .	170
<b>Table 279.</b>	Polling during programing after sequential write in User memory when write operation allowed and all bytes belong to same area . . . . .	171
<b>Table 280.</b>	Sequential write in User memory when write operation allowed and crossing over area border . . . . .	171
<b>Table 281.</b>	Polling during programming after sequential write in User memory when write operation allowed and crossing over area border . . . . .	172
<b>Table 282.</b>	Sequential write in mailbox when mailbox is free from RF message and fast transfer mode is activated . . . . .	172
<b>Table 283.</b>	Polling during programing after sequential write in mailbox . . . . .	172
<b>Table 284.</b>	Current byte Read in User memory if read operation allowed (depending on area protection and RF user security session) . . . . .	173
<b>Table 285.</b>	Current Read in User memory if read operation not allowed (depending on area protection and RF user security session) . . . . .	173
<b>Table 286.</b>	Random byte read in User memory if read operation allowed (depending on area protection and RF user security session) . . . . .	174
<b>Table 287.</b>	Random byte read in User memory if operation not allowed (depending on area protection and RF user security) . . . . .	174
<b>Table 288.</b>	Byte Read System memory (Static register or I <sup>2</sup> C Password after a valid Present I <sup>2</sup> C Password) . . . . .	175
<b>Table 289.</b>	Random byte read in Dynamic registers . . . . .	175
<b>Table 290.</b>	Sequential Read User memory if read operation allowed (depending on area protection and RF user security session) and all bytes belong to the same area . . . . .	176
<b>Table 291.</b>	Sequential Read User memory if read operation allowed (depending on area protection and RF user security session) but crossing area border . . . . .	177
<b>Table 292.</b>	Sequential Read User memory if read operation allowed (depending on area protection and RF user security session) . . . . .	178
<b>Table 293.</b>	Sequential in Read System memory (I <sup>2</sup> C security session open if reading I2C_PWD) . . . . .	179
<b>Table 294.</b>	Sequential Read system memory when access is not granted (I <sup>2</sup> C password I2C_PWD) . . . . .	180
<b>Table 295.</b>	Sequential read in dynamic register . . . . .	181
<b>Table 296.</b>	Sequential read in Dynamic register and mailbox continuously if fast transfer mode is activated . . . . .	182
<b>Table 297.</b>	Sequential in mailbox if fast transfer mode is activated . . . . .	183
<b>Table 298.</b>	Sequential read in mailbox if fast transfer mode is not activated . . . . .	184
<b>Table 299.</b>	Write Password when I <sup>2</sup> C security session is already open and fast transfer mode is not activated . . . . .	185
<b>Table 300.</b>	Write Password when I <sup>2</sup> C security session is not open or fast transfer mode activated . . . . .	186
<b>Table 301.</b>	Present Password (whatever status of I <sup>2</sup> C security session or fast transfer mode) . . . . .	187
<b>Table 302.</b>	Document revision history . . . . .	188



## List of figures

<b>Figure 1.</b>	ST25DVxxKC block diagram . . . . .	3
<b>Figure 2.</b>	ST25DVxxKC 8-pin SO8N package connections. . . . .	4
<b>Figure 3.</b>	ST25DVxxKC 8-pin TSSOP8 package connections. . . . .	4
<b>Figure 4.</b>	ST25DVxxKC 8-pin UDFN8 package connections . . . . .	5
<b>Figure 5.</b>	10-ball WLCSP package connections . . . . .	5
<b>Figure 6.</b>	ST25DVxxKC 12-pin UDFPN12 package connections . . . . .	6
<b>Figure 7.</b>	ST25DVxxKC power-up sequence (No RF field, LPD pin tied to $V_{SS}$ or package without LPD pin). . . . .	9
<b>Figure 8.</b>	ST25DVxxKC RF power-up sequence (No DC supply) . . . . .	10
<b>Figure 9.</b>	Memory organization. . . . .	12
<b>Figure 10.</b>	ST25DVxxKC user memory areas. . . . .	14
<b>Figure 11.</b>	RF to I <sup>2</sup> C fast transfer mode operation. . . . .	25
<b>Figure 12.</b>	I <sup>2</sup> C to RF fast transfer mode operation. . . . .	25
<b>Figure 13.</b>	Fast transfer mode mailbox access management. . . . .	27
<b>Figure 14.</b>	ST25DVxxKC, Arbitration between RF and I <sup>2</sup> C. . . . .	31
<b>Figure 15.</b>	I <sup>2</sup> C “RFSwitchOff” command . . . . .	32
<b>Figure 16.</b>	I <sup>2</sup> C “RFSwitchOn” command . . . . .	32
<b>Figure 17.</b>	RF_USER chronogram . . . . .	34
<b>Figure 18.</b>	RF_ACTIVITY chronogram . . . . .	35
<b>Figure 19.</b>	RF_INTERRUPT chronogram. . . . .	36
<b>Figure 20.</b>	FIELD_CHANGE chronogram . . . . .	37
<b>Figure 21.</b>	RF_PUT_MSG chronogram . . . . .	38
<b>Figure 22.</b>	RF_GET_MSG chronogram . . . . .	39
<b>Figure 23.</b>	RF_WRITE chronogram . . . . .	40
<b>Figure 24.</b>	GPO/I2C_WRITE chronogram . . . . .	41
<b>Figure 25.</b>	GPO/I2C_RF_OFF chronogram . . . . .	42
<b>Figure 26.</b>	EH delivery state diagram . . . . .	50
<b>Figure 27.</b>	ST25DVxxKC Energy Harvesting Delivery Sequence . . . . .	51
<b>Figure 28.</b>	RF security sessions management . . . . .	60
<b>Figure 29.</b>	I <sup>2</sup> C security sessions management . . . . .	61
<b>Figure 30.</b>	I <sup>2</sup> C bus protocol . . . . .	67
<b>Figure 31.</b>	I <sup>2</sup> C timeout on Start condition . . . . .	68
<b>Figure 32.</b>	Write mode sequences when write is not inhibited. . . . .	72
<b>Figure 33.</b>	Write mode sequences when write is inhibited . . . . .	72
<b>Figure 34.</b>	Write cycle polling flowchart using ACK . . . . .	73
<b>Figure 35.</b>	Read mode sequences . . . . .	74
<b>Figure 36.</b>	I <sup>2</sup> C Present Password Sequence . . . . .	76
<b>Figure 37.</b>	I <sup>2</sup> C Write Password Sequence . . . . .	76
<b>Figure 38.</b>	ST25DVxxKC protocol timing . . . . .	78
<b>Figure 39.</b>	ST25DVxxKC state transition diagram. . . . .	79
<b>Figure 40.</b>	Stay Quiet frame exchange between VCD and ST25DVxxKC. . . . .	88
<b>Figure 41.</b>	Read Single Block frame exchange between VCD and ST25DVxxKC . . . . .	89
<b>Figure 42.</b>	Extended Read Single Block frame exchange between VCD and ST25DVxxKC . . . . .	90
<b>Figure 43.</b>	Write Single Block frame exchange between VCD and ST25DVxxKC . . . . .	91
<b>Figure 44.</b>	Extended Write Single frame exchange between VCD and ST25DVxxKC . . . . .	93
<b>Figure 45.</b>	Lock Block frame exchange between VCD and ST25DVxxKC . . . . .	94
<b>Figure 46.</b>	Extended Lock block frame exchange between VCD and ST25DVxxKC . . . . .	95
<b>Figure 47.</b>	Read Multiple Block frame exchange between VCD and ST25DVxxKC . . . . .	96
<b>Figure 48.</b>	Extended Read Multiple Block frame exchange between VCD and ST25DVxxKC . . . . .	98
<b>Figure 49.</b>	Write Multiple Block frame exchange between VCD and ST25DVxxKC . . . . .	99
<b>Figure 50.</b>	Extended Write Multiple Block frame exchange between VCD and . . . . .	101
<b>Figure 51.</b>	Select frame exchange between VCD and ST25DVxxKC. . . . .	102

<b>Figure 52.</b>	Reset to Ready frame exchange between VCD and ST25DVxxKC	103
<b>Figure 53.</b>	Write AFI frame exchange between VCD and ST25DVxxKC	104
<b>Figure 54.</b>	Lock AFI frame exchange between VCD and ST25DVxxKC	105
<b>Figure 55.</b>	Write DSFID frame exchange between VCD and ST25DVxxKC	106
<b>Figure 56.</b>	Lock DSFID frame exchange between VCD and ST25DVxxKC	107
<b>Figure 57.</b>	Get System Info frame exchange between VCD and ST25DVxxKC	109
<b>Figure 58.</b>	Extended Get System Info frame exchange between VCD and ST25DVxxKC	113
<b>Figure 59.</b>	Get Multiple Block Security Status frame exchange between VCD and	114
<b>Figure 60.</b>	Extended Get Multiple Block Security Status frame exchange between VCD and ST25DVxxKC	116
<b>Figure 61.</b>	Read Configuration frame exchange between VCD and ST25DVxxKC	117
<b>Figure 62.</b>	Write Configuration exchange between VCD and ST25DVxxKC	119
<b>Figure 63.</b>	Read Dynamic Configuration frame exchange between VCD and ST25DVxxKC	120
<b>Figure 64.</b>	Write Dynamic Configuration frame exchange between VCD and ST25DVxxKC	121
<b>Figure 65.</b>	Manage GPO frame exchange between VCD and ST25DVxxKC	122
<b>Figure 66.</b>	Write Message frame exchange between VCD and ST25DVxxKC	123
<b>Figure 67.</b>	Read Message Length frame exchange between VCD and ST25DVxxKC	124
<b>Figure 68.</b>	Read Message frame exchange between VCD and ST25DVxxKC	125
<b>Figure 69.</b>	Fast Read Message frame exchange between VCD and ST25DVxxKC	126
<b>Figure 70.</b>	Write Password frame exchange between VCD and ST25DVxxKC	128
<b>Figure 71.</b>	Present Password frame exchange between VCD and ST25DVxxKC	129
<b>Figure 72.</b>	Fast Read Single Block frame exchange between VCD and ST25DVxxKC	130
<b>Figure 73.</b>	Fast Extended Read Single Block frame exchange between VCD and ST25DVxxKC	131
<b>Figure 74.</b>	Fast Read Multiple Block frame exchange between VCD and ST25DVxxKC	133
<b>Figure 75.</b>	Fast Extended Read Multiple Block frame exchange between VCD and ST25DVxxKC	134
<b>Figure 76.</b>	Fast Write Message frame exchange between VCD and ST25DVxxKC	136
<b>Figure 77.</b>	Fast Read Message Length frame exchange between VCD and ST25DVxxKC	137
<b>Figure 78.</b>	Fast Read Dynamic configuration frame exchange between VCD and ST25DVxxKC	138
<b>Figure 79.</b>	Fast Write Dynamic Configuration frame exchange between VCD and ST25DVxxKC	139
<b>Figure 80.</b>	AC test measurement I/O waveform	142
<b>Figure 81.</b>	I <sup>2</sup> C AC waveforms	148
<b>Figure 82.</b>	I <sup>2</sup> C Fast mode ( $f_C = 1$ MHz): maximum $R_{bus}$ value versus bus parasitic capacitance ( $C_{bus}$ )	148
<b>Figure 83.</b>	ASK modulated signal	151
<b>Figure 84.</b>	SO8N – Outline	152
<b>Figure 85.</b>	SO8N - Recommended footprint	153
<b>Figure 86.</b>	TSSOP8 – Outline	154
<b>Figure 87.</b>	TSSOP8 – Recommended footprint	155
<b>Figure 88.</b>	UFDFN8 - Outline	156
<b>Figure 89.</b>	WLCSP - 10 balls, 1.649x1.483 mm, 0.4 mm pitch, wafer level chip scale package outline	158
<b>Figure 90.</b>	WLCSP - 10 balls, 1.649x1.483 mm, 0.4 mm pitch, wafer level chip scale recommended footprint	159
<b>Figure 91.</b>	UFDFPN12 - Outline	160
<b>Figure 92.</b>	Logic 0, high data rate, fast commands	162
<b>Figure 93.</b>	Logic 1, high data rate, fast commands	162
<b>Figure 94.</b>	Logic 0, low data rate, fast commands	162
<b>Figure 95.</b>	Logic 1, low data rate, fast commands	163
<b>Figure 96.</b>	Start of frame, high data rate, one subcarrier, fast commands	163
<b>Figure 97.</b>	Start of frame, low data rate, one subcarrier, fast commands	163
<b>Figure 98.</b>	End of frame, high data rate, one subcarrier, fast commands	164
<b>Figure 99.</b>	End of frame, low data rate, one subcarrier, fast commands	164



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